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EVALUATION OF DISHWASHING SYSTEMS IN FOOD SERVICE ESTABLISHMENTS

Marketing Research Report No. 1003

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PREFACE

Material presented in this report was developed under contract by Associated Food Industry Services (AFIS), Ltd., Rockville, Md.

Acknowledgment for their cooperation and assistance is gratefully given to Richard N. Brown, executive vice president, the National Restaurant Association, Chicago, Ill.; to Robert N. Smith, Vernon E. Cordell, and other members of the National Restaurant Association's Ad Hoc Committee on U.S. Department of Agriculture Research; and to John S. Cockrell, executive vice president, Restaurant Association of Metropolitan Washington.

Special credit is due to the owners, operators, and personnel who made their facilities available for detailed study at the following food service operations: Adam's Rib Restaurant, All States Cafeteria, Costin's Sirloin Room, Golden Ox Restaurant, The Hecht Company, Hogate's Seafood Restaurant, Kays Sandwich Shop, Restaurant 823, and The Three Thieves Restaurant of Washington, D.C.; Post Cafeteria, Alexandria, Va.; and Evans Farm Inn, McLean, Va.

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This study was conducted under the general direction of R.W. Hoecker, formerly Assistant Director, Transportation and Facilities Research Division, Agricultural Research Service.

This type of research is presently being continued under the auspices of the Food Distribution Research Laboratory, Agricultural Marketing Research Institute, Agricultural Research Service, Beltsville, Md. 20705.

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EVALUATION OF DISHWASHING SYSTEMS IN FOOD SERVICE ESTABLISHMENTS

by

John F. Freshwater and Daniel M. Steckler[1]

SUMMARY

This study indicates that the average dishwashing system in the restaurants and cafeterias evaluated is operating at less than two-thirds of peak efficiency. If efficiency were at 100 percent, an annual savings of nearly $21,000 per restaurant could be realized.

During table clearing, the large-tray method was the least expensive and the most productive for restaurants providing intensive, moderate, and minimal service. In cafeterias, however, the self-bussing method proved best.

A direct comparison of dishwashing methods was not made because of the different capacities of the dish machines. However, on a cost basis in both restaurants and cafeterias, the three-carousel dish machines were the most productive, while the two-tank conveyor rack proved least expensive.

On a total cost basis, the dish cart method of storing clean tableware (excluding nonwashables) was almost 10 percent less than the manual method. It was also considerably more productive (almost 3 to 1) on a man-hours requirement basis.

When the total dishwashing system is examined, the most efficient and least expensive setup for a restaurant is the large-tray method of clearing tables, a two-tank conveyor rack to wash dishes, and the dish cart method of storing clean tableware (excluding nonwashables). In a cafeteria, the only change would be using the self-bussing method of clearing tables.

The least cost method of improving a dishwashing system could result in an annual savings of almost $24,000. An annual savings of $20,000 can be realized in improving a conventional system by transferring selected work assignments from dishwashing to table clearing, thereby providing a more even distribution.

A model dishwashing system has a potential savings of nearly $21,000 per year and the advantage of increasing dish machine capacity by 15 percent. The annual savings mentioned in the least cost method, improving a conventional system and designing a model system, are all based on food service establishment number six in this study. Redesign of work tables and the introduction of proper layouts reduce handling costs and improve efficiency.

A final method of improving the diswashing system is to develop innovative equipment, such as collapsible dishracks and special dining room stations, for scrapping, sorting, and racking dishes as they are being removed from tables.

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INTRODUCTION

Traditionally, washing dishes has been regarded as one of the least desirable tasks in a food service operation. Probably, there have been numerous intangible psychological reasons and tangible physical factors related to both manual and machine dishwashing that have contributed to this attitude. The majority of food service operators who participated in this study indicated that they had more difficulty in recruiting, training, and retaining employees who handled and washed soiled tableware than they had with any other group. In this study, tableware is defined as all items (plates, saucers, bowls, cups and silverware) including nonwashables (linen napkins, tablecloths, and breadbaskets). To improve working conditions, productivity, and sanitation, approximately 28 percent of the total public food service establishments in this country have installed dish machines.

At present, the majority of food service operators do not have a reliable method of determining and isolating the specific costs for washing dishes. The most common method currently used is to divide the total labor cost for dish room and bussing employees by gross sales. This labor-cost-to-gross-sales ratio is a poor measurement indicator, because both wage rates and menu prices fluctuate. Also, costs for equipment and supplies are not included, and the degree of labor use is not considered.

This research study was designed to provide food service operators with management tools to enable them to determine the amount of standard man-hours and costs associated with specific types of dishwashing systems. Standard man-hours are defined as the product of normal time multiplied by a personal and fatigue allowance. Normal time is defined as either the product of recorded time multiplied by the pace-rating factor or the summation of universal standard data time increments for basic hand, arm, body, and foot movements. Costs are defined as the summation of costs per 1,000 washable pieces for productive labor, equipment, utilities, maintenance repairs, supplies, and washable tableware.

A dishwashing system is composed of three separate but interdependent tasks. The first of these is clearing soiled tableware from tables in a dining area and transporting them to a dishwashing station, which is normally located in the kitchen. The second is washing the soiled tableware. The third is transporting and storing them at points of reuse. Another objective of this study was to develop a model dishwashing system and to make recommendations for improving existing conventional dishwashing systems.

The dollar values presented in this publication for processing costs for specific dishwashing systems were not developed for universal use and adoption by the industry. The variability of labor and utility rates, and the cost of supplies, building space, and capital investment for equipment preclude the practicality of such application. However, since all rates were uniformly applied, the processing costs shown provide the reader with relative values which may be used to compare specific types of dishwashing systems. The standard man-hours shown for specific dishwashing systems may be used by all food service operators as basic building blocks for the development of time and cost standards for a specific food service operation.

When properly applied and analyzed, standard man-hours and cost values provide the criteria for more perceptive and appropriate decisions regarding dishwashing systems. Standard man-hours and cost measures provide management with: (1) Accurate data on the amount of standard man-hours required for a specific volume of tableware; (2) a performance index which indicates the level of labor utilization; (3) a means of comparing the processing costs for specific dishwashing systems; and (4) the means of evaluating the need for methods improvements or their effect and the time period required to regain the capital investment. The immediate value of using productive man-hours is improved labor use through better work scheduling. Therefore, it is important that the reader have an understanding of the nature, applicability, and limitations of this research.

The data presented in this publication were obtained from an analysis of 12 restaurants in the metropolitan Washington, D.C., area. Restaurants were selected on the basis of volume of dishes processed, type of customer service rendered, and type of dishwashing equipment and operating practices used in washing and handling dishes.

Table 1 presents a profile of the 12 food service operations which participated in this study. All data obtained and comments included in this report are directed primarily to commercial businesses patronized by the general public. A glossary of terms used in this report is located in appendix exhibit A. A detailed explanation of the research methodology used in this research is presented in appendix exhibit B.

TABLE 1.–Profile of dishwashing systems in the 12 food service operations analyzed

Food service operation	Type of Service[1]	Average daily customer count	Seat count	Average washable pieces per day	Method of clearing tables	Type of dish machine	Method of storing clean tableware
Number		*Number*	*Number*	*Number*			
1	Table (I)	675	275	9,335	Large-tray	Conveyor-rack	Manual
2	Cafeteria	1,350	300	15,161	Cart	do	Cart
3	do	1,350	300	13,244	Small-tray	Flight	Do.
4	Table (M)	700	155	7,007	do	Door	Manual
5	Table (I)	600	400	7,368	Large-tray	Flight	Cart
6	do	2,500	600	29,700	Small-tray	Conveyor-rack	Manual
7	Table (M)	800	250	8,176	Cart	Carousel I	Do.
8	Table (I)	1,000	500	14,600	do	Flight	Cart
9	do	500	325	5,565	Large-tray	Carousel I	Manual
10	Table (O)	300	110	2,835	Bus-pan	Door	Do.
11	do	1,000	115	8,340	do	do	Do.
12	Table (I)	1,335	215	15,606	Large-tray	Carousel I	Cart
Average		1,009	295	11,411			

[1] (I) indicates intensive; (M) indicates moderate; and (O) indicates minimal service.

STANDARD MAN-HOURS AND COSTS TO CLEAR TABLES

The amount of standard man-hours and the costs to clear tables are dependent upon the type of table service, the number of pieces of tableware cleared, and the methods and equipment used.

Type of Table Service

Table service varies from very intense in deluxe dining rooms to none in cafeterias and self-service restaurants. The more intensive the service, the more frequently the soiled tableware is cleared from tables, and the fewer number of pieces that are carried each time.

Intensive, moderate, minimal, and cafeteria-type services are all evaluated in this study.

Service is usually intensive in an occasion-type restaurant, where linen tablecloths and a centerpiece are part of the table setting. During the course of a meal, the waiter or busboy clears the table three times. First, he clears the salad dishes; second, the main course; third, the remaining tableware on the table after the customers have left.

Moderate service is usually provided by family-type restaurants. Here, paper place mats and paper napkins are part of the table setting. The waiter clears the table twice during the meal: First, the salad and main course; and second, the remaining tableware after the customers have left.

Minimal service is usually associated with a family-type restaurant that has a limited seating capacity. To reduce the amount of time spent by customers at their tables, tables are cleared just once, after the customers have left. In cafeteria service, the customer obtains his own food on a tray. A busboy clears the table after the customers have left.

Table 2 shows a summary of tableware used in studies of intensive service, and table 3 a summary of cafeteria, minimal, and moderate service. The number of pieces washed varies from an average of nine per customer in one restaurant (Case Study No. 11) to 15 in another restaurant (Case Study No. 8). These averages do not include breadbaskets, tablecloths, napkins, and disposable bottles, which do not undergo dishwashing. These nonwashable items account for approximately 17 percent of the total.

TABLE 2.–Summary of tableware used in food service operations that feature intensive service

Food service operation	Flat dish-ware	Cups	Glasses washed in dish room	Pitchers	Silver ware	Glasses washed else where	Non-washables	Total cleared from table	Total tableware washed[1]
1—pieces/100 customers	576	93	135	73	506	98	316	1,797	1,383
5 do	468	88	202	19	451		280	1,508	1,228
6 do	495	104	98	19	472	66	200	1,454	1,188
8 do	644	107	183	25	501		302	1,762	1,460
9 do	451	88	99	46	429	76	279	1,468	1,113
12 do	456	93	109	46	465	82	302	1,553	1,169
Totals–number of pieces per 600 customers	3,090	573	826	228	2,824	322	1,679	9,542	7,541
Average cleared–number of pieces per 100 customers	515	96	138	38	471	54	280	1,592	1,258
Average cleared–percent	32.35	6.03	8.67	2.39	29.58	3.39	17.59	100.00	79.02
Average washed do	40.94	7.63	10.97	3.02	37.44	—	—	—	100.00
Average washed–distribution per 1,000	410	76	110	30	374	—	—	—	1,000
Dishrack capacity–number of pieces per rack	19	20	20	20	100	—	—	—	
Average racks–number per 1,000 pieces[2]	22	4	6	2	4	—	—	—	38

[1] Total tableware washed = total cleared from table, minus nonwashables, plus glasses washed elsewhere.

[2] Rounded to the nearest whole number.

TABLE 3.–Summary of tableware used in food service operations, comparing cafeteria, minimal, and moderate services[1]

Food service operation	Flat dish-ware	Cups	Glasses	Pitchers	Silver-ware	Non-wash-ables	Total cleared from table	Total tableware washed[2]
2—number of pieces per 100 customers	448	122	164	0	389	170	1,293	1,123
3 do	463	92	107	8	311	169	1,150	981
4 do	449	97	98	51	306	200	1,201	1,001
7 do	418	84	167	23	330	226	1,248	1,022
10 do	445	95	98	0	307	139	1,084	945
11 do	360	91	103	0	280	133	967	834
Totals–number of pieces per 600 customers	2,583	581	737	82	1,923	1,037	6,943	5,906
Average cleared–number of pieces per 100 customers	431	97	123	14	321	713	1,159	986
Average cleared–percent	37.18	8.37	10.61	1.21	27.70	14.93	100.00	85.07
Average washed do	43.71	9.84	12.47	1.42	32.56	—	—	100.00
Average washed–distribution per 1,000	438	98	125	14	325	—	—	1,000
Dishrack capacity–number of pieces per rack	19	20	20	20	100	—	—	—
Average racks[3]–number per 1,000 pieces	22	5	7	1	4	—	—	39

[1] Operation numbers 2 and 3, cafeteria service; numbers 4 and 7, moderate service; and numbers 10 and 11 minimal service.

[2] Total tableware washed equals total cleared from table, minus nonwashables.

[3] Rounded to the nearest whole number.

Methods and Equipment Used

Five common ways to clear soiled tableware from tables are small-tray, large-tray, bus-pan, bus-cart and self-bussing methods.

Small Trays

Figure 1 shows a small tray to clear tables. This method is based on the concept that as a waiter walks to the kitchen to place an order to to pick up food, he can also carry soiled tableware. First, he carries the tray to the table and loads it with soiled tableware. Next, he carries the loaded tray to the dish room. Here, he unloads them on to decoys on the soiled-dish table. Decoys are groups of different types of dishes that show the waiter where to place each piece of soiled tableware (excluding nonwashables).

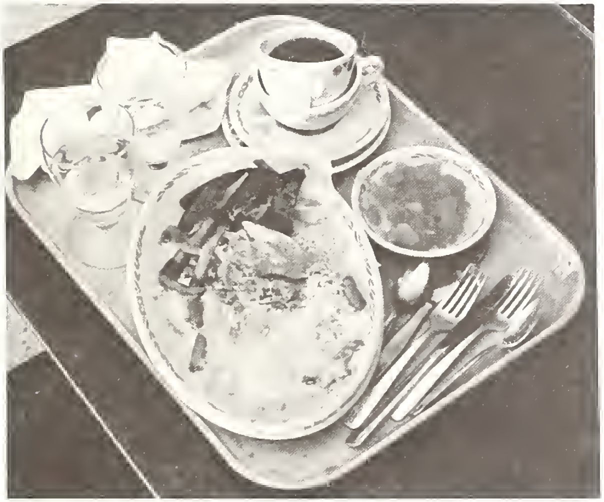

Figure 1.—Small-tray method.

The waiter wipes the tray clean manually for conveyor-rack, flight, and door dish machines. However, if a carousel dish machine is used, the waiter leaves the trays loaded with soiled tableware in the dish room on a storage rack and obtains clean trays. Although standard man-hours for carrying small trays of soiled dishes to the kitchen were charged against the dishwashing system, return times were not.

Large Trays

Figure 2 shows a large tray to clear soiled tableware. After the waiter has served his customers food from the tray, he places it on a nearby stand. This method is based on the concept that when a waiter brings large trays of food into a dining room, the emptry trays which remain on the stands can be used for returning soiled tableware to the kitchen. Since waiters clear soiled tableware in handfuls, the number of pieces which can be cleared in one trip is limited by the capacity of worker's hands.

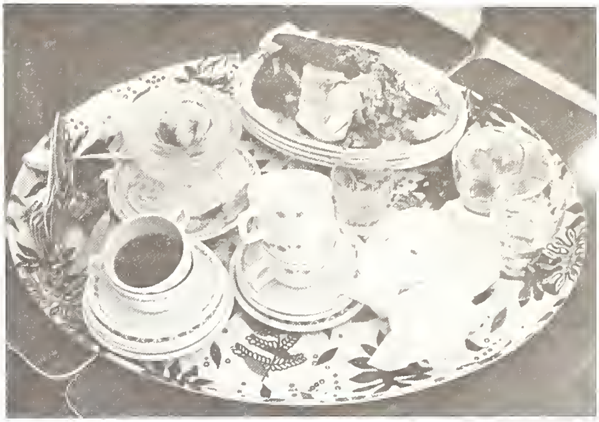

Figure 2.—Large-tray method.

On initial clearing, the waiter or busboy carries the soiled tableware to a tray stand. For the final clearing, he carries the tray to the table and then returns it to its stand. He repeats these steps for a second table, and then carries the tray to the dish room and places it on the soiled-dish table. Since clean trays are recirculated to the dining room, the standard man-hours for this task were omitted.

Bus Pans

Figure 3 shows a bus pan to clear soiled tableware. This method is similar to clearing tables using large

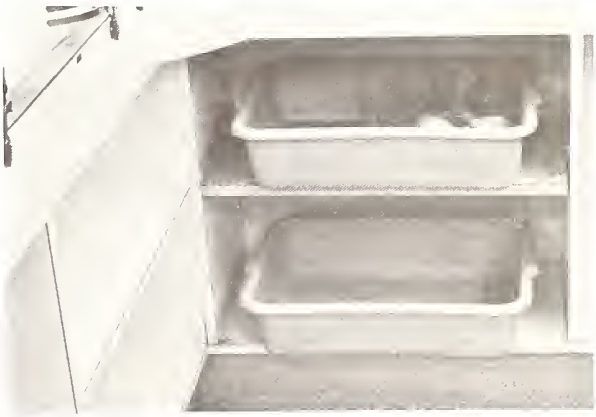

Figure 3.—Bus-pan method.

trays on stands. On initial clearing, the waiter carries the soiled tableware to the bus pans. The bus pan is then carried to the table for the final clearing and then returned to its stand. These steps are repeated for a second table, and then the bus pan is carried to the dish room and placed on a soiled-dish table. A clean bus pan is returned to the dining room. Two-way time is charged against the dishwashing system, since bus pans are used only for handling soiled tableware.

Bus Carts

Figure 4 shows a waitress clearing soiled tableware by using a bus cart. The soiled tableware is carried to bus pans located on nearby carts. Here, they are sorted, and the nonwashables placed aside in containers attached to these carts. On the initial clearing, the waiter carries the soiled tableware to the bus cart. The bus pan is carried on to the table for final clearing, and the pan is then returned to the bus cart.

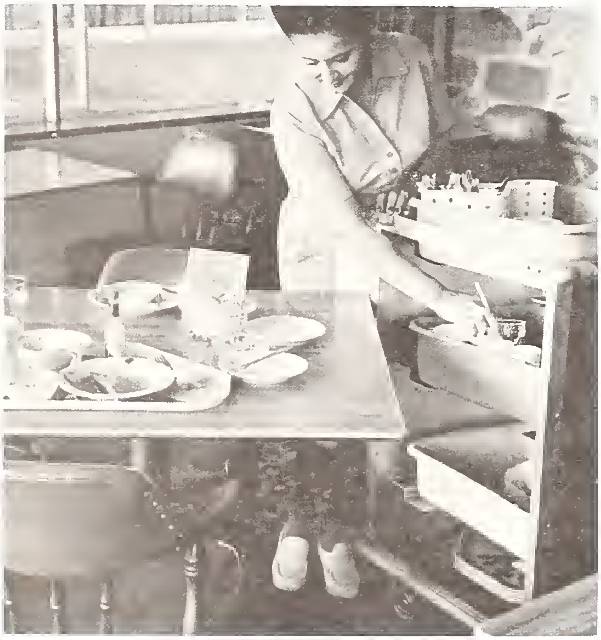

Figure 4.—Bus-cart method.

This procedure is repeated for 10 tables. The bus cart is then moved to the dish room. Here, the bus pans are unloaded from the cart and placed on the soiled-dish table. The bus cart is restocked with clean pans and returned to the dining room. Although the number of bus pans per cart may vary from one establishment to another, the productive values and costs developed in this publication are based on five bus pans per cart. Two-way time is charged against the dishwashing system.

Self-Bussing

Figure 5 shows a self-bussing cart which is used by a customer to clear his own soiled tableware from the table. After a customer has finished his meal, he takes the tray of soiled tableware to a stand or rack. Time to wipe the tables clean is not included in this study, because the frequency of occurrence is dependent upon management practices within a specific operation.

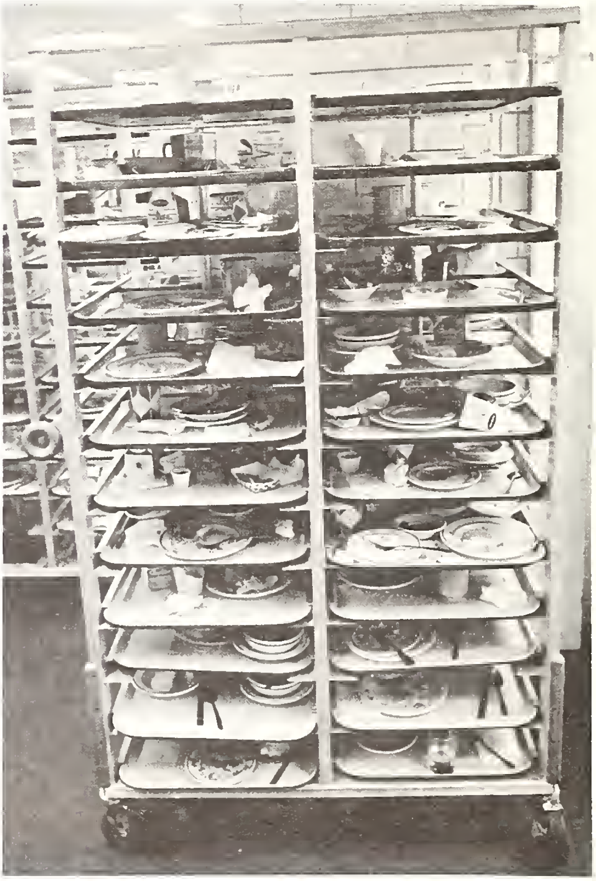

Figure 5.—Self-bussing method.

Comparison of the Different Methods

A comparison of standard man-hours and cost for clearing tables is shown in table 4. This table shows that for intensive, moderate, and minimal service in restaurants, the large-tray method is the most productive in standard man-hours required and the least expensive in total cost. It is 27 percent more productive and 25 percent less expensive than the small-tray method; 29 percent more productive and 30 percent less expensive than bus pans; and 5 percent more productive and 17 percent less expensive than bus carts. In cafeteria-type service, the self-bussing method is the most productive in man-hours required and the least expensive in total cost. It is 25 times more productive and 8 times less expensive than the small-tray method, 19 times more productive and 6 times less expensive than the bus-pan method, and 18 times more productive and 6½ times less expensive than the bus-cart method.

TABLE 4.–Standard man-hours and costs per 1,000 washable pieces for table-clearing task

Equipment used and type of service	Standard man-hours	Labor cost [1]	Equipment & supplies cost	Floor-space cost	Total costs
	Hours	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Small trays–conveyor rack, flight, and door type:					
Intensive	2.142	5.634	0.007	0	5.641
Moderate	1.645	4.326	.007	0	4.333
Minimal	1.220	3.209	.007	0	3.216
Cafeteria	1.561	4.105	.007	0	4.112
Small trays–carousel:					
Intensive	2.017	5.305	.021	0	5.326
Moderate	1.528	4.019	.021	0	4.040
Minimal	1.109	2.917	.021	0	2.938
Cafeteria	1.450	3.814	.021	0	3.835
Large trays:					
Intensive	1.629	4.284	.021	.038	4.343
Moderate	1.187	3.122	.021	.038	3.181
Minimal	.992	2.609	.021	.038	2.668
Cafeteria					
Bus pans:					
Intensive	2.267	5.962	.056	.075	6.093
Moderate	1.580	4.155	.056	.075	4.286
Minimal	1.061	2.790	.056	.075	2.921
Cafeteria	1.146	3.014	.056	.075	3.145
Bus carts:					
Intensive	1.744	4.587	.301	.182	5.070
Moderate	1.214	3.193	.301	.182	3.676
Minimal	1.013	2.664	.301	.182	3.147
Cafeteria	1.072	2.819	.301	.182	3.302
Self-bussing———Cafeteria	.059	.155	.166	.182	.503
Average	1.382	3.635	.089	.066	3.790

[1] Standard man-hours multiplied by the average hourly rate of $2.63.

STANDARD MAN-HOURS AND COSTS TO WASH TABLEWARE

The amount of standard man-hours and costs to wash tableware (excluding nonwashables) is dependent upon the type of dishwashing station, the number of pieces of soiled tableware washed, and whether the dishwashing station is located in a restaurant or in a cafeteria. Standard man-hours and cost are influenced by the layout of a specific dishwashing station. A well-designed station will reduce dish-handling and walking requirements. The standard man-hours and costs shown in this report incorporate the best layout design features and operating methoas of dishwashing operations evaluated in this research.

Types of Dishwashing Stations and Operating Methods

In this study, the type of dishwashing station, layout, and operating methods are identified by the type of dish machine used. The four types of dishwashing stations evaluated were door, conveyor-rack, carousel, and flight.

All modern dish machines have at least three washing cycles: A detergent wash between 140° and 160°F.; a hot-water rinse between 160° and 180°; and a sterilizing rinse at least 180°. Some machines also have a fourth wash which is positioned before the detergent wash, and which is used as a prewash for removing light scraps from tableware. Machines equipped with prewash nozzles eliminate the need to spray-rinse flat tableware manually.

Since water is recycled in all washes except during the final sterilizing rinse, the number of washes available in a machine is identified by a reference to the number of tanks. For example, a three-tank machine has a prewash, a detergent wash, and a hot-water rinse, as well as a sterilizing rinse. A two-tank machine has only a detergent wash and a hot-water rinse, as well as a sterilizing rinse. Door machines are normally equipped with one tank. Conveyor-rack machines are available in a choice of either two or three tanks. Flight and carousel machines are normally equipped with three tanks.

Door Dishwashing Station

Figure 6 shows a door-type dish machine, and figure 7 shows the station layout.

When small trays are used, dining room personnel place tableware on decoys on the soiled-dish table (fig. 7, item 1), silverware in the portable silverware soaking sink (item 2), nondisposables in the trash can (item 3), and then wipe the trays by hand. When large trays or bus pans are used, the soiled-dish carrier is left on the soiled-dish table. Nondisposables and silverware are removed from the bus pan or large tray in the same manner as for the small tray. After moving flat and inverted tableware and placing them in storage, the dishwasher manually spray-rinses the large trays and bus pans at the prerinse sink (item 6).

The dishwasher at the soiled-dish table places inverted tableware into racks located on the overshelf. He then dumps garbage from the flat tableware into the scrap trough (item 4) before placing the tableware on a rack on the table top. He pushes these racks of flat tableware over the prerinse sink (item 6) and manually spray-rinses them before placing them in the dish machine (item 7). The dishwasher then loads soiled silverware from the portable silverware soaking sink (item 2) into a flat silverware rack and loads these directly into the machine. He also loads filled racks of inverted tableware directly, one at a time, from the overshelf into the machine. The dishwasher closes the door manually and depresses the "on" or "start" button.

Most door-type dish machines have automatic cycling. Upon depression of the "on" or "start" button, the equipment cycles automatically through a detergent wash and a sanitizing final rinse. When the cycles are completed, the machine automatically turns off. The door-type dish machines evaluated in this research had a capacity of 60 racks per hour.

The dishwasher working at the clean dish table (item 8) raises the door manually and pulls the rack of clean tableware from the machine onto the table surface. He then unloads the flat tableware from the rack and, depending on the handling method used for storing clean tableware, places them in a clean dish cart or temporarily stores them in similar stacks on the table top. Inverted tableware is left in the rack and transported to clean dish storage either manually or with clean dish carts. Clean silverware is removed from the flat silverware rack, sorted into silverware cylinders, and temporarily stored on the overshelf above the clean dish table. Empty flatware and silverware racks

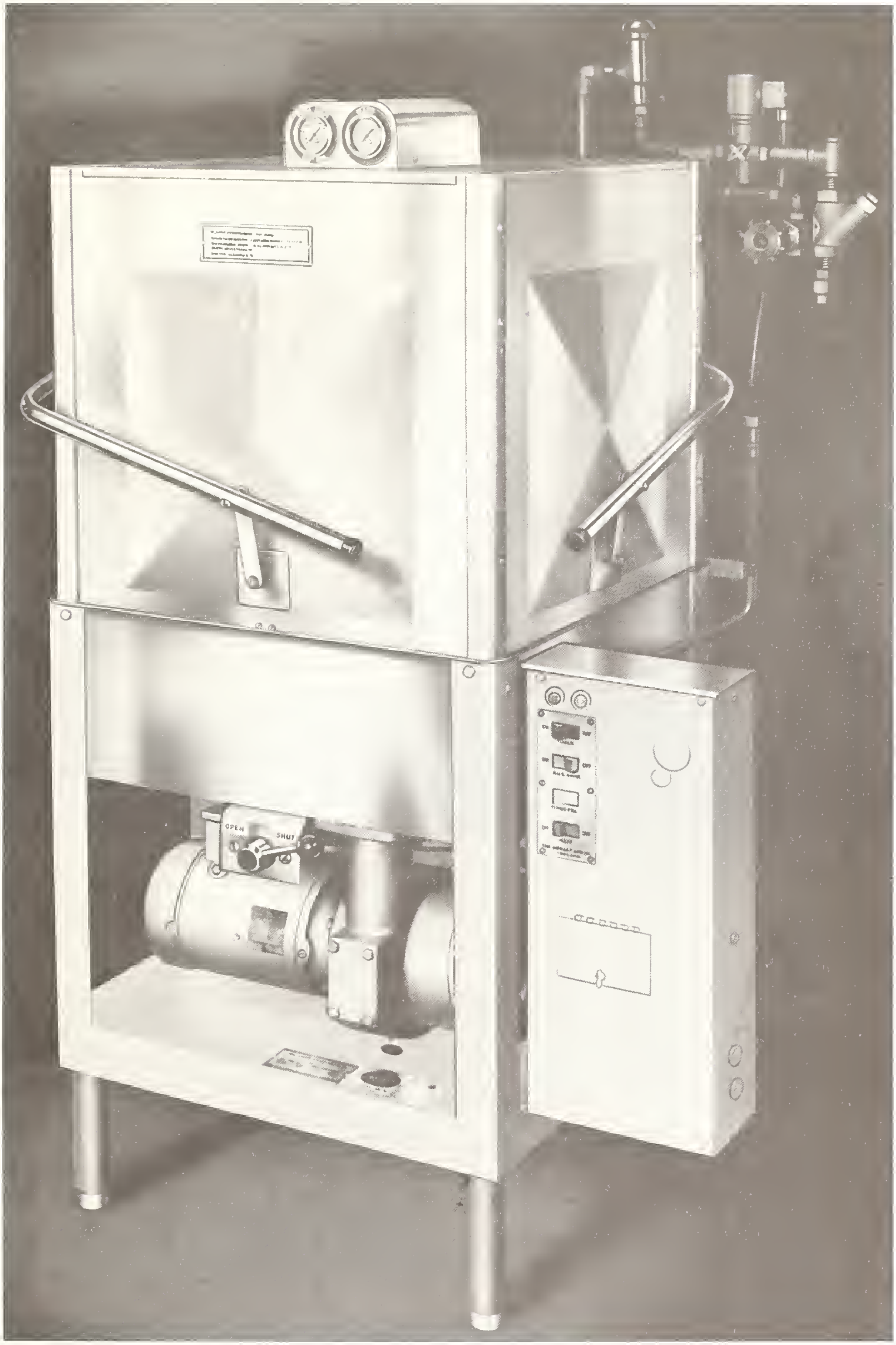

Figure 6.—Door-type dish machine.

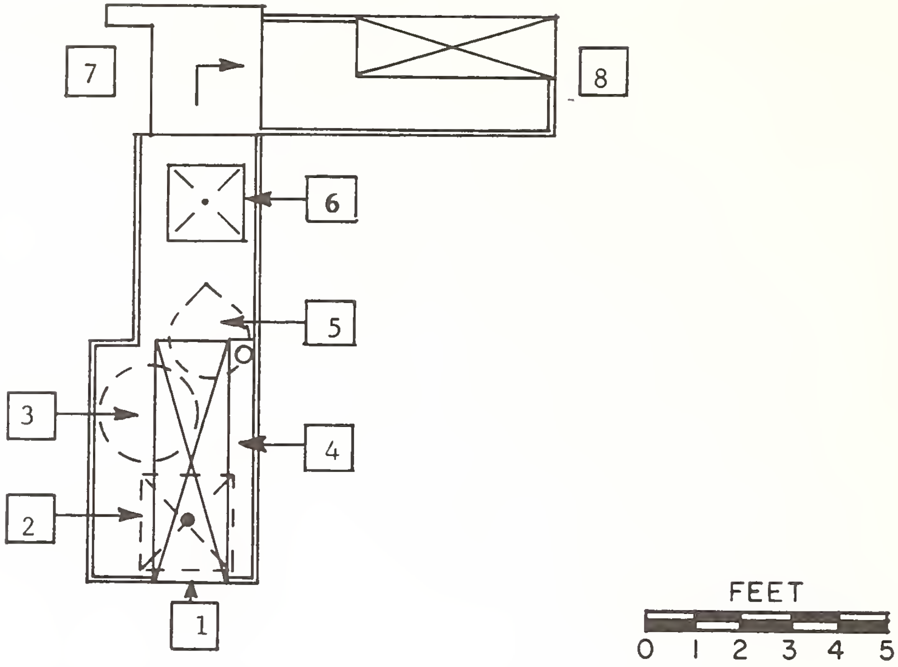

Figure 7.–Layout for door dishwashing station: 1, Soiled-dish table with overshelf for inverted dishrack; 2, portable silverware soaking sink; 3, trash can; 4, scrap trough; 5, disposal (3 hp.); 6, prerinse sink with overhead spray; 7, dish machine; 8, clean dish table with overshelf.

are hand-carried from the clean dish table to the soiled dish table.

The layout shown for the door dishwashing station has sufficient working space for two dishwashers–one at the soiled-dish table and one at the clean dish table.

Conveyor Rack Dishwashing Station

Figure 8 shows a two-tank, conveyor-rack dish machine. This type of dish machine is available with either two or three tanks. Figure 9 shows the layout for a two-tank conveyor-rack dishwashing station, and figure 10 shows a three-tank, conveyor-rack station.

Dishwashers generally handle soiled-dish carriers and tableware the same as for the door-type dishwashing station. There are two exceptions: (1) The method of inserting racks into the dish machine and (2) the way in which large trays are placed in racks and processed through the machine.

Conveyor-rack dish machines have a continuous chain conveyor which carries filled racks through automatic washing and rinsing cycles. As soon as space becomes available on the conveyor, the dishwasher places a second rack directly behind the first at the entry end of the machine. As a result, more than one rack of tableware at a time normally passes through the machine. The conveyor pushes the racks of clean tableware onto the clean dish table (fig. 9, item 8). The two-tank, conveyor-rack dish machines evaluated in this research had a capacity of 234 racks per hour, while the three-tank, conveyor-rack machines had a capacity of 360 racks per hour.

Racks of clean, flat tableware and inverted tableware are picked up at the exit end of the machine and placed in storage the same as for the door-type dishwashing station. Racks of clean silverware are carried to the silverware sorting table (item 9) and sorted into silver cylinders.

The two-tank, conveyor-rack dishwashing station shown in figure 9 has sufficient working space for three dishwashers at the soiled-dish table, for two dishwashers at the clean dish table (item 8), and for one dishwasher at the silverware sorting table (item 9).

The layout shown for the three-tank, conveyor-rack dishwashing station in figure 10 is similar to the layout for the two-tank, conveyor-rack dishwashing station (fig. 9), except that it requires more floor space for

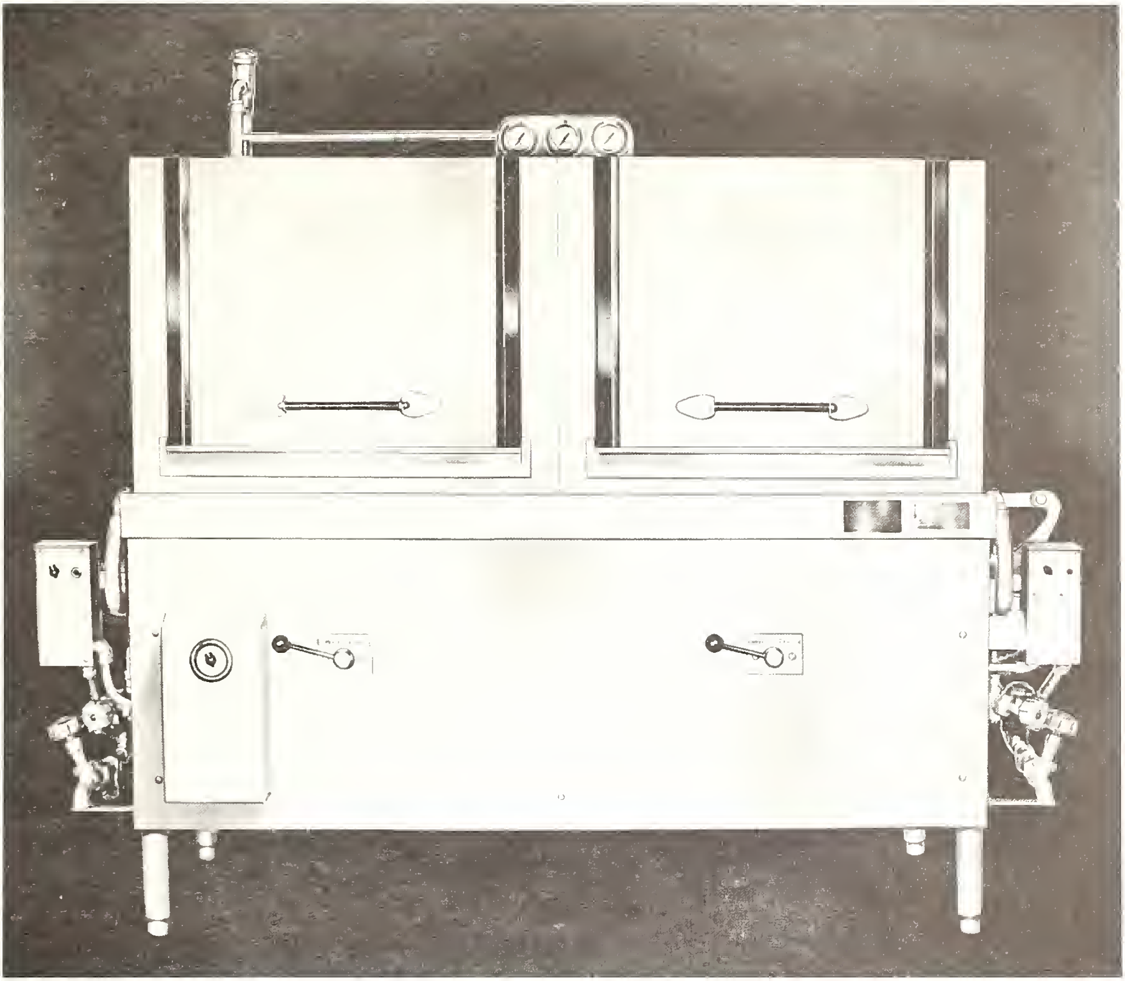

Figure 8.–Two-tank, conveyor-rack dish machine.

longer tables and a larger dish machine. A prerinse sink is not required. Large and small trays, bus pans, and tableware are processed just like in the two-tank, conveyor-rack dishwashing station. There is one exception: flat tableware is not prerinsed. The addition of the third tank to the dish machine eliminates the need to prerinse.

Besides eliminating the prerinse operation, three-tank, dish machines have approximately 50-percent-greater capacity than do two-tank machines. For this reason, the soiled-dish table (item 4) and the clean dish table (item 8) shown in figure 10 have been lengthened to provide working space for four dishwashers and three dishwashers, respectively.

Carousel Dishwashing Station

Figure 11 shows the layout for a carousel-type-1 dishwashing station. The basic piece of equipment of the carousel dishwashing station is a modified conveyor-rack-type dish machine (fig. 12, item 8). In this dishwashing station, the conveyor has been extended through the dish machine in a continuous, oval-shaped loop. The flat tableware racks are an integral part of the conveyor. Sometimes, floor space restrictions make a triangular or square-shaped configuration appropriate.

Conveyor-rack dish machines with capacities of 180, 387, and 480 racks per hour were evaluated in this

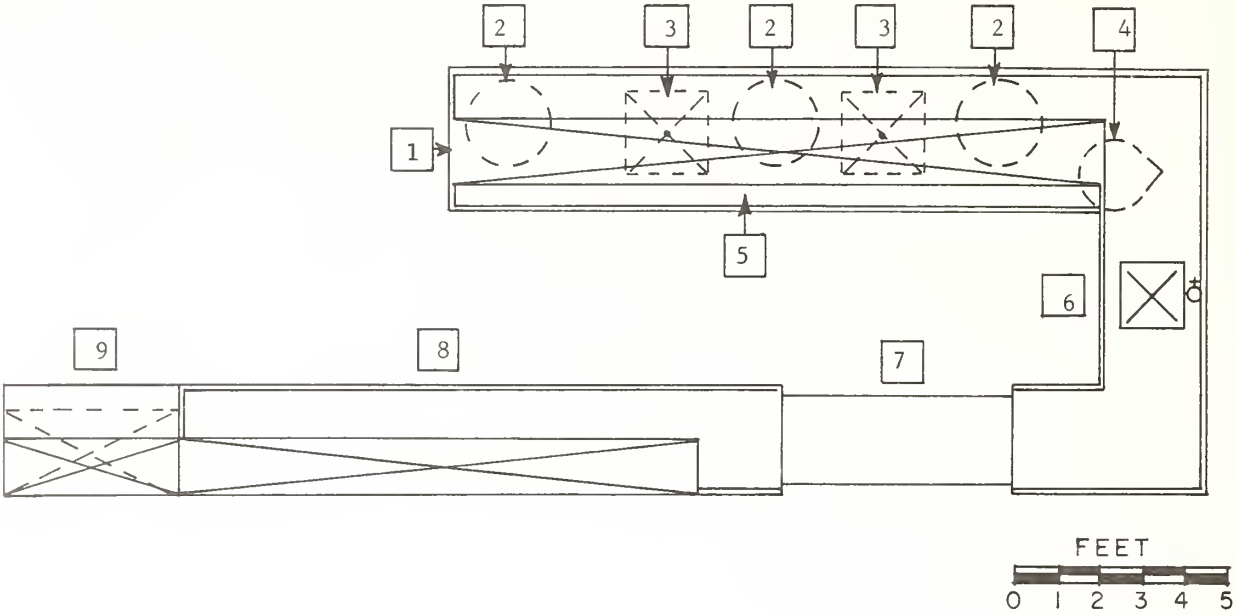

Figure 9.–Layout for a two-tank, conveyor-rack dishwashing station: 1, Soiled-dish table with overshelves for inverted dishracks (2); 2, trash cans (3); 3, portable silverware soaking sinks (2); 4, disposal (5 hp.); 5, scrap trough; 6, prerinse sink with overhead spray; 7, two-tank dish machine; 8, clean dish table with overshelf; 9, silverware sorting table with overshelf and undershelf.

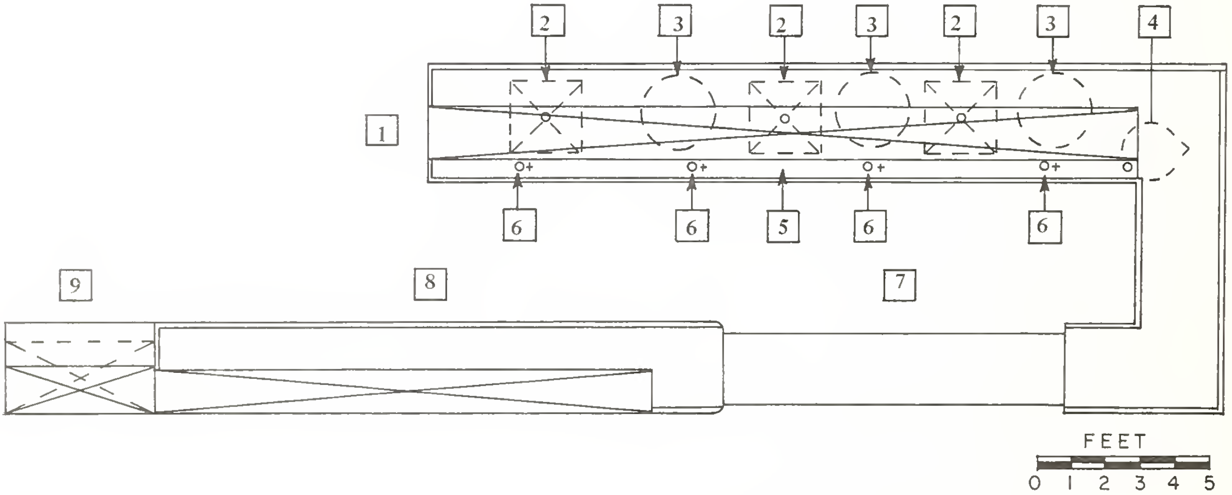

Figure 10.–Layout for a three-tank, conveyor-rack dishwashing station: 1, Soiled-dish table with overshelf for inverted dishracks; 2, portable silverware soaking sinks (3); 3, trash cans (3); 4, disposal (5 hp.); 5, scrap trough; 6, suspended spray-rinse arm (4); 7, three-tank dish machine; 8, clean dish table with overshelf; 9, silverware sorting table with overshelf and undershelf.

study. The carousel dishwashing stations associated with these conveyor-rack machines were classified as types 1, 2, and 3, respectively.

Dining room personnel deposit soiled tableware carried on either small trays, large trays, or bus pans on the soiled-dish storage rack (fig. 11, item 1) and pick up a clean dish carrier from the same rack. One of the two dishwashers who handle soiled tableware picks up the soiled tableware from the carrier and places them on the scrap trough (item 6). The dishwasher places

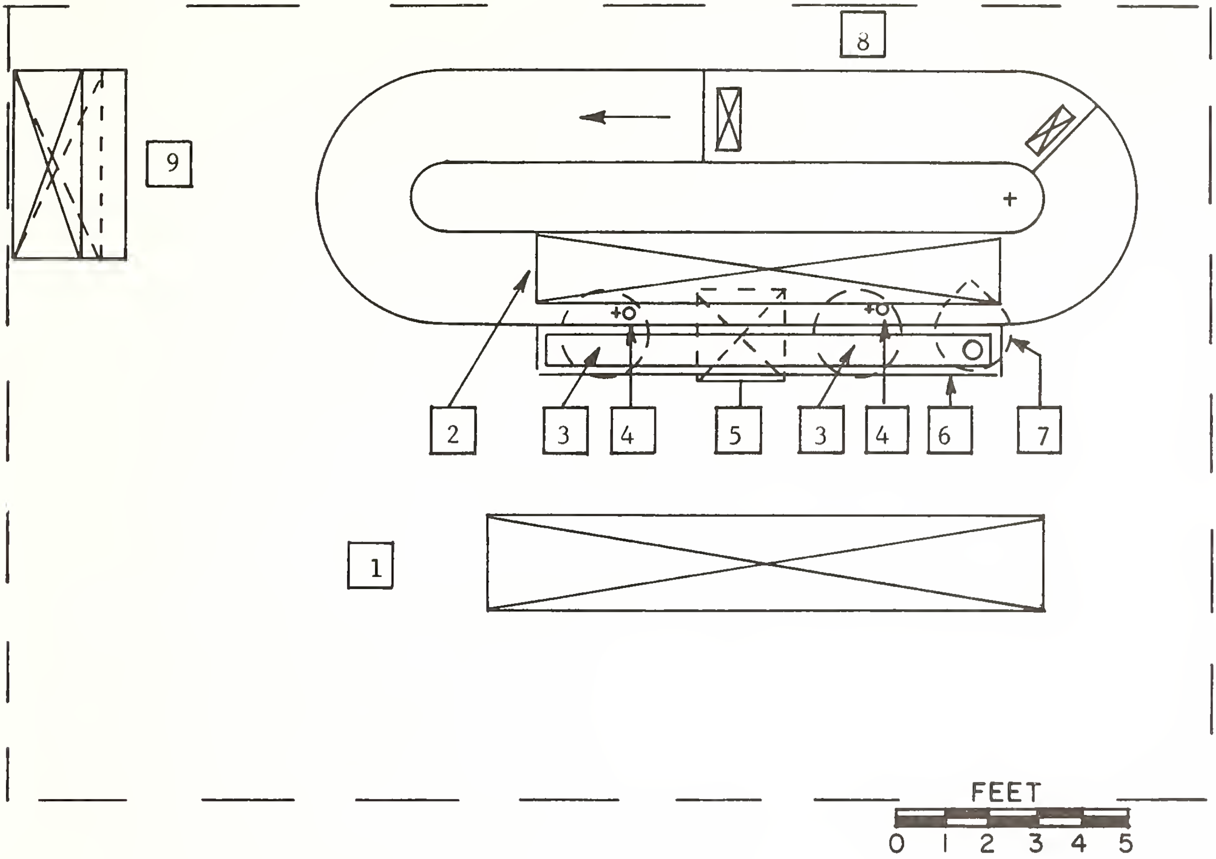

Figure 11.–Layout for carousel-type-1 dishwashing station: 1, Soiled-dish storage rack; 2, overshelves (2) for inverted dishracks; 3, trash cans (2); 4, overhead spray (2); 5, portable silverware soaking sink; 6, scrap trough; 7, disposal (5 hp.); 8, dish machine; 9, silverware sorting table with overshelf and undershelf.

nondisposables in the trash can (item 3), silverware in the portable silverware soaking sink (item 5), and inverted tableware in the appropriate rack on the bottom overhself. Empty inverted tableware racks are stored on the top overshelf.

The dishwasher removes filled racks of inverted tableware from the bottom overshelf on top of the moving flatware racks attached to the conveyor. The dishwasher then dumps garbage from the flat tableware into the scrap trough and places the tableware directly into the moving rack attached to the conveyor. He also places both small and large trays directly into the moving flatware racks. If dining room personnel use them, bus pans are spray-rinsed with the suspended spray-rinse arm (fig. 11, item 4).

The carousel dishwashing station layouts for types 2 and 3 are identical with the layout shown in figure 11. One difference is that types 2 and 3 are 10 and 15 feet longer in overall lengths, respectively. Both types have conveyor-rack dish machines with greater capacity and longer length. Carousel-type-2 and type-3 layouts have sufficient working space and equipment for three men and four men, respectively, to handle soiled tableware.

Flight Dishwashing Station

Figure 13 shows a flight-type dish machine, while figure 14 shows its station's layout. Dishwashers treat soiled dishes and carriers the same as with the conveyor-rack dishwashing station. In the one exception, the dishwasher carries the soiled tableware in stacks from the soiled-dish table (item 1) and places them on the soiled-dish transfer table (item 6). Normally, a second dishwasher picks up the tableware and loads them directly into the continuous-belt conveyor of the dish machine (item 7).

Flight-type dish machines operate on the same principle as conveyor-rack machines. However, flight machines require more floor space, because their overall dimensions and capacity are greater than those of conveyor rack machines. The continuous-belt conveyor on flight machines is constructed with vertical fingers which permit placing flat tableware directly on the conveyor. The flight machines evaluated in this research had an effective capacity of 8,500 pieces per hour.

Clean tableware is unloaded at the exit end of the dish machine and placed in storage. A silverware sorting table (item 8) has been provided for silverware sorting.

The layout shown for the flight-type dishwashing station has sufficient working space for four dishwashers at the soiled-dish table (item 1), for two at the soiled-dish transfer table (item 6) and at the exit end (item 7), of the machine, respectively, and for one at the silverware sorting table (item 8).

Standard Man-Hours and Costs

Table 5 shows the standard man-hours and costs of washing tableware. The man-hours required to wash tableware is least for the carousel-type-3 dish machines in both restaurants and cafeterias. On a total cost basis, the two-tank conveyor rack is the least expensive for both restaurant and cafeteria service. A direct comparison of the equipment was not made because of the different capacities of the machines. As discussed in the introduction, dishwashing can be an undesirable

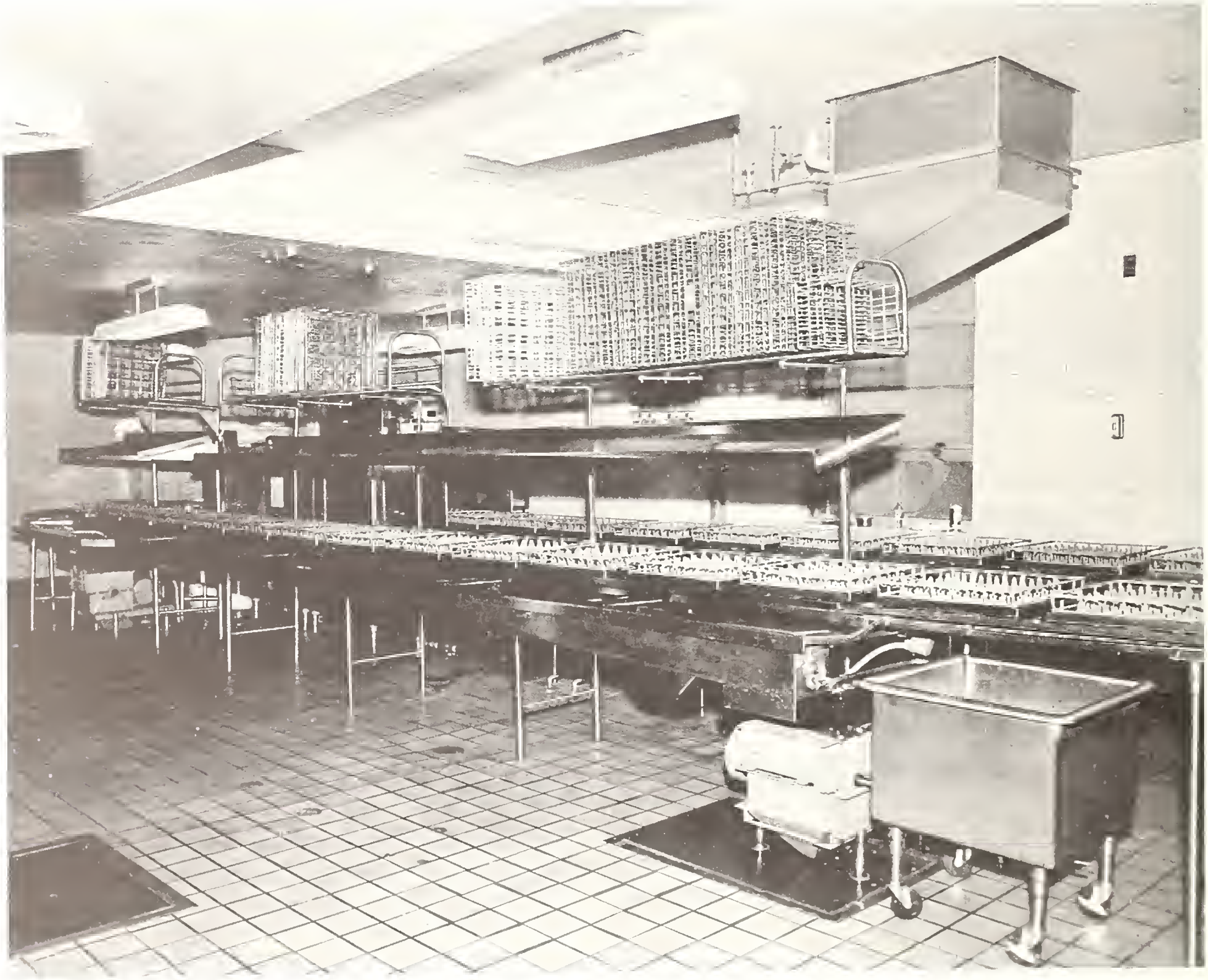

Figure 12.–Carousel-type dish machine.

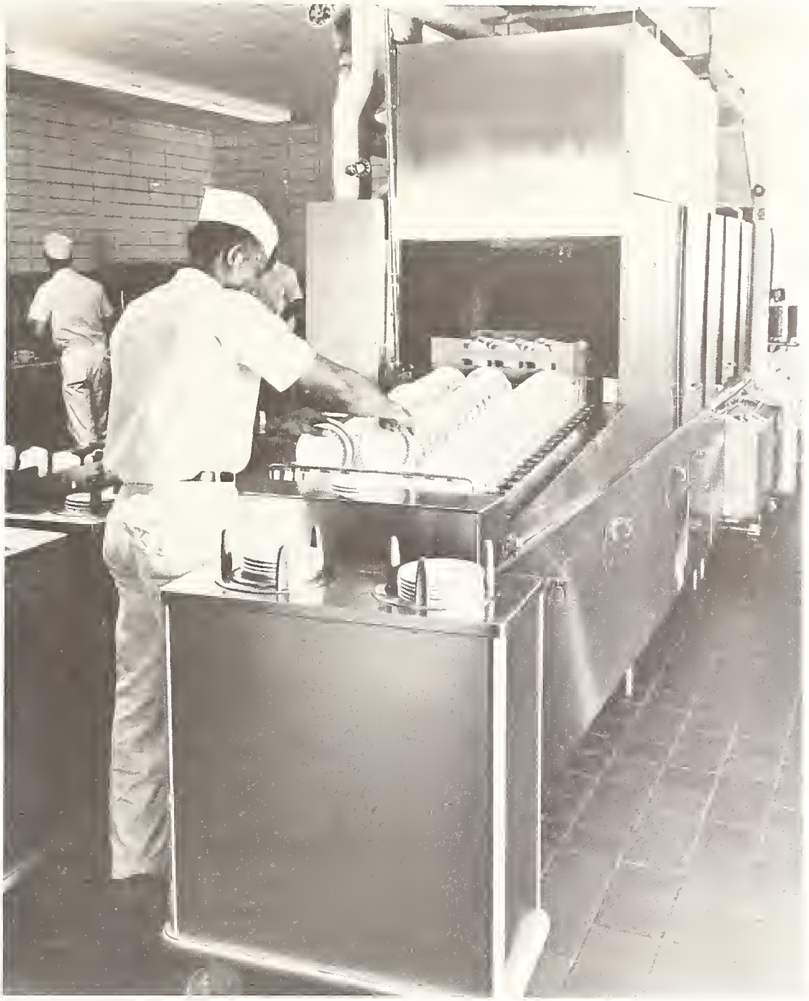

Figure 13.–Flight-type dish machine.

task, and management has a different time keeping and motivating dishwashing help. Labor-turnover cost data were not included, but should be considered for an overall view. Higher priced equipment should be considered if it will eliminate some of the manpower necessary to wash tableware.

As can be seen from table 5, the capacity of the different dish machines in pieces per hour vary greatly. In restaurant, service, when the capacity is 1,400 pieces per hour, a door-type machine should be used. If the capacity is between 3,000 and 5,200 pieces per hour, either the carousel-type-1 or a two-tank conveyor rack is best. When the capacity is between 7,000 and 9,000 pieces per hour, a choice from the carousel-type-2, the carousel-type-3, the flight-type, or the three-tank conveyor rack is recommended. If cafeteria service, when the capacity of the machine is 1,100 pieces per hour, a door-type machine should be used. If the capacity is between 3,000 and 4,100 pieces per hour, either a carousel-type-1 or a two-tank conveyor rack can be selected. When the capacity is between 6,000 and 8,100 pieces per hour, a choice from the carousel-type-2, the carousel-type-3, the flight-type, or the three-tank conveyor rack is suggested.

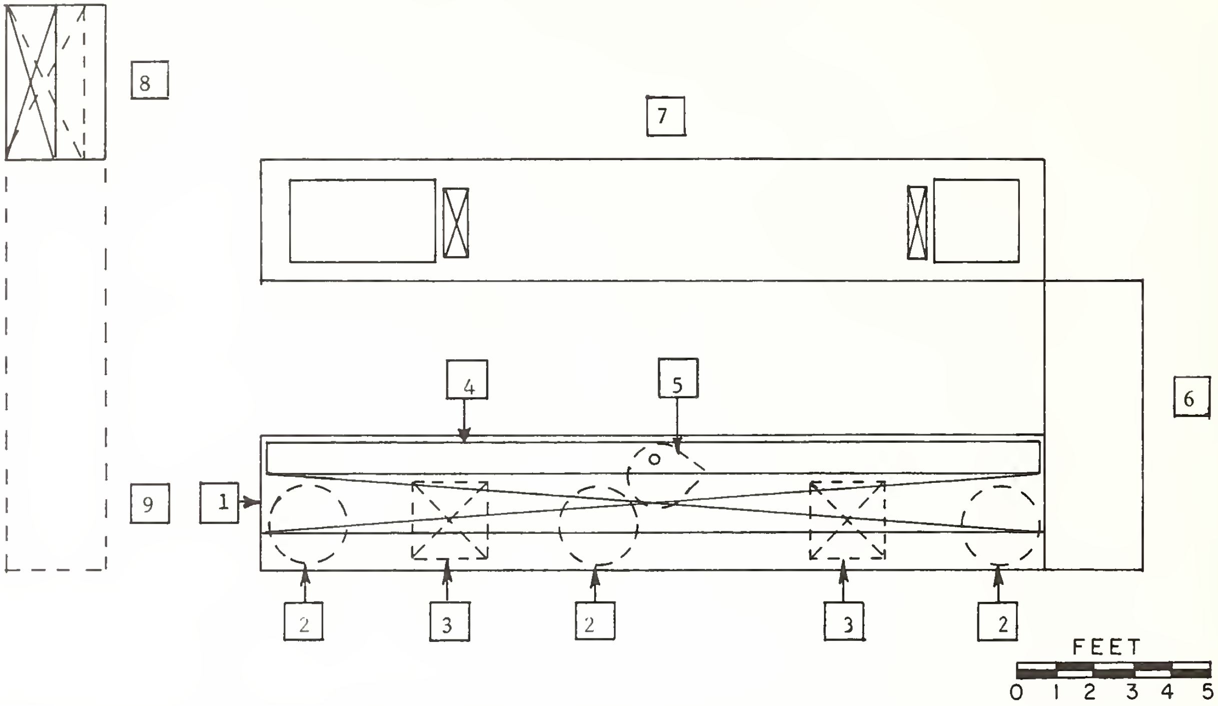

Figure 14.–Layout for a flight-type dishwashing station: 1, Soiled-dish table with overshelf for inverted dishracks; 2, trash cans (3); 3, portable silverware soaking sinks (2); 4, scrap trough; 5, disposal (5 hp.); 6, soiled-dish transfer table; 7, dish machine; 8, silverware sorting table; 9, temporary storage area for clean tableware.

TABLE 5.–Standard man-hours and costs per 1,000 washable pieces for the dishwashing task

Dishwashing station	Type of service	Average capacity of dishwashing crew	Average size of dishwashing crew	Standard man-hours	Labor cost [1]	Equipment and supplies: Owning	Equipment and supplies: Operating	Floor space	Total costs
		Pieces/hour	*Number*	*Hours*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Conveyor-rack (2-tank)	Restaurant	5,220	5	1.021	2.685	0.317	0.466	1.292	4.760
Conveyor-rack (2-tank)	Cafeteria	4,180	5	1.196	3.145	.395	.466	1.292	5.298
Conveyor-rack (3-tank)	Restaurant	8,053	8	.956	2.514	.259	.506	1.561	4.840
Conveyor-rack (3-tank)	Cafeteria	6,195	7	1.131	2.975	.336	.506	1.561	5.378
Flight	Restaurant	7,193	6	.880	2.314	.419	.419	1.871	5.023
Flight	Cafeteria	7,075	8	1.059	2.785	.426	.419	1.871	5.501
Door 1 unit	Restaurant	1,413	2	1.412	3.714	.608	.519	.348	5.189
Door 1 unit	Cafeteria	1,100	2	1.812	4.766	.780	.519	.348	6.413
Carousel-Type-1	Restaurant	3,127	3	.846	2.225	.845	.546	1.623	5.239
Carousel-Type-1	Cafeteria	3,055	3	.983	2.585	.865	.546	1.623	5.619
Carousel-Type-2	Restaurant	7,030	6	.846	2.225	.565	.546	2.327	5.663
Carousel-Type-2	Cafeteria	6,095	6	.983	2.585	.652	.546	2.327	6.110
Carousel-Type-3	Restaurant	9,053	8	.846	2.225	.508	.546	2.679	5.958
Carousel-Type-3	Cafeteria	8,130	8	.983	2.585	.565	.546	2.679	6.375

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[1] Standard man-hours multiplied by the average hourly rate of $2.63.

STANDARD MAN-HOURS AND COSTS TO STORE CLEAN TABLEWARE

The standard man-hours and costs required to store clean tableware depend on the methods and equipment used. The clean tableware may be transferred to storage either manually or with dish carts. When the manual storing method is used, flat tableware is sorted into similar stacks on the clean dish table.

When a stack of approximately 20 pieces has accumulated, the dishwasher hand-carries the stack from the clean dish table to a clean dish storage rack. Inverted tableware is left in the rack and carried directly to the clean dish storage rack. Clean tableware is subsequently removed from the clean dish storage rack and manually transported to points of reuse in the kitchen and in the dining room.

Figure 15 shows a dishwasher storing clean tableware with a dish cart. When this storing method is used, flat tableware is sorted into similar stacks on the cart. When loaded, the cart is pushed to points of reuse and unloaded. Inverted tableware is left in the rack and loaded directly onto a lowerator cart.

Table 6 shows the standard man-hours and costs for both methods associated with the clean tableware storing task. As shown in the table, the standard man-hours per 1,000 washable pieces for storing clean tableware with carts is considerably less (almost 3 to 1) than for storing them manually. A comparison of the two methods shows that storing tableware on dish carts costs almost 10 percent less than storing them manually. The main savings result from the increased amount of tableware carried per trip and the reduction in walking time.

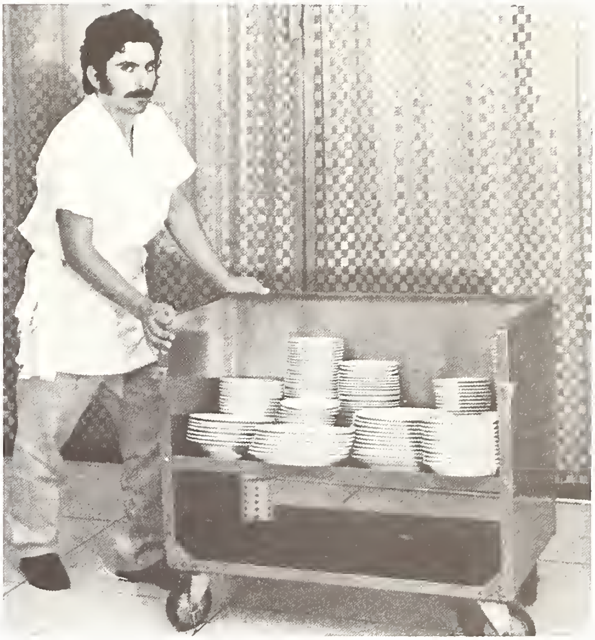

Figure 15.–Storing clean tableware with a dish cart.

TABLE 6.–Standard man-hours and costs per 1,000 washable pieces for storing clean tableware

Method and equipment used	Standard man-hours	Labor cost [1]	Equipment	Floor space	Total costs
	Hours	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Dish carts	0.162	0.426	0.954	0.596	1.976
Manual	.476	1.252	.295	.646	2.193
Average	.319	.839	.625	.621	2.085

[1] Standard man-hours multiplied by the average hourly rate of $2.63.

SYSTEM COSTS AND LABOR ANALYSIS

For management control and analysis, the most practical way to evaluate the overall efficiency of a specific dishwashing system is on a total cost basis and on the analysis of labor utilization in the dining room and in the kitchen, because employees are normally allocated on this basis. The cost per 1,000 washable pieces for a specific dishwashing system was determined by adding the costs for the table-clearing task, for the dishwashing task, and for the clean-tableware-storing task.

Table 7 indicates system costs for restaurants and table 8, for cafeterias. Both tables demonstrate that for all types of dishwashing stations, the large-tray method in restaurants and the self-bussing method in cafeterias are least expensive for the table-clearing task, while the dish-cart method is least costly for the clean-dish-storing task.

Standard man-hours per 1,000 washable pieces for the table-clearing task (dining room) and for the dishwashing and clean-tableware-storing tasks (kitchen) are the basis for scheduling man-hours and for analyzing labor performance. These are illustrated in tables 4, 5, and 6.

Procedure for Using Cost and Standard Man-Hour Data

Costs, standard man-hour requirements, and labor utilization for a restaurant that averages 800 customers per day and that offers moderate dining room service are calculated. The bus-cart-method was used for the table-clearing task, and a flight dishwashing station and manual storing methods for the dishwashing and clean-tableware-storing tasks. The results of these calculations are shown in table 9.

The first step is determining the average number of washable pieces of tableware per day. A practical way is to sample at random the number of washable pieces of tableware per customer during a 1-week period. The total number of washable pieces per day is then determined by multiplying the average number of pieces by the average daily customer count. The average number of washable pieces for the example restaurant was 10.2, and the number of washable pieces per day was 8,160 (10.2 washable pieces per customer multiplied by 800 per day).

The second step is determining the cost for the dishwashing system and the standard man-hours for the table-clearing task and for both the dishwashing and the clean-tableware-storing tasks. Reference to table 7 shows that the cost per 1,000 washable pieces for this system is $10.892. Reference to table 4 indicates that the standard man-hours per 1,000 washable pieces for the table-clearing task is 1.214. Reference to tables 5 and 6 establishes that the sum of the standard man-hours per 1,000 washable pieces for the dishwashing (0.880 man-hours) and for the clean-tableware-storing tasks (0.476 man-hours) is 1.356. The data ($10.892 and 1.214 and 1.356) are multiplied by 8.160 man-hours (8,160 washable pieces divided by 1,000) to yield the costs and standard man-hours shown in table 9.

The third step is determining the actual man-hours per day for the table-clearing task and for both the dishwashing and the clean-tableware-storing tasks. An expedient method is to determine from timeclock cards the total man-hours of bussing employees for the table-clearing task and of dishwashing employees for the dishwashing and clean-tableware-storing tasks. In those establishments which use both bus boys and waiters, or only waiters, for the table-clearing task, multiply the total man-hours by a percentage estimate of time spent on this task. The actual man-hours of the example restaurant are shown in table 9.

The fourth step is determining the percentage of labor utilization. This percentage is calculated by dividing the standard man-hours by the actual man-hours per day and multiplying the result by 100. The result of this calculation is also shown in table 9.

The significance of the data shown in table 9 is:

- The cost of the dishwashing system at 100-percent labor utilization is 11 cents per customer ($87.32 total process cost divided by 800 customers).
- The actual cost of the dishwashing system at the current level of 63.3-percent labor utilization is approximately 15 cents per customer (33.2 actual man-hours minus 21.0 productive man-hours, times $2.63 labor rate, plus $88, divided by 800 customers).
- Cost savings of 4 cents per customer could be realized through improved management practices.

Corresponding management action should be taken either to reduce the number of man-hours through improved scheduling or to assign additional tasks to employees, or both.

Costs and Labor Utilization In The Participating Food Service Operations

Table 10 shows the costs, labor performance, and potential annual savings for the food service operations that participated in this research. The average annual cost at 100-percent labor utilization was $57,245 per operation. Based on 363 operating days per year and a

TABLE 7.–Summary of total costs per 1,000 washable pieces for conventional dishwashing systems in restaurants

Dishwashing station	Clean-tableware-storing method	Intensity of service and table-clearing method											
		Minimal				Moderate				Intensive			
		Bus carts	Bus pans	Large tray	Small tray	Bus carts	Bus pans	Large tray	Small tray	Bus carts	Bus pans	Large tray	Small tray
		Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Conveyor-rack (2-tank)	Manual	10.100	9.874	9.621	10.169	10.629	11.239	10.134	11.286	12.023	13.046	11.296	12.594
Conveyor-rack (2-tank)	Cart	9.883	9.657	9.404	9.952	10.412	11.022	9.917	11.069	11.806	12.829	11.079	12.377
Conveyor-rack (3-tank)	Manual	10.180	9.954	9.701	10.249	10.709	11.319	10.214	11.366	12.103	13.126	11.376	12.674
Conveyor-rack (3-tank)	Cart	9.963	9.737	9.484	10.032	10.492	11.102	9.997	11.149	11.886	12.909	11.159	12.457
Flight	Manual	10.363	10.137	9.884	10.434	10.892	11.502	10.397	11.549	12.286	13.309	11.559	12.857
Flight	Cart	10.146	9.920	9.667	10.215	10.675	11.285	10.180	11.332	12.069	13.092	11.342	12.640
Door	Manual	10.529	10.303	10.050	10.598	11.058	11.668	10.563	11.715	12.452	13.477	11.725	13.023
Door	Cart	10.312	10.086	9.833	10.381	10.841	11.451	10.346	11.498	12.235	13.258	11.508	12.806
Carousel-Type-1	Manual	10.579	10.353	10.100	10.370	11.108	11.719	10.613	11.472	12.502	13.525	11.775	12.758
Carousel-Type-1	Cart	10.362	10.136	9.883	10.153	10.891	11.502	10.396	11.255	12.285	13.308	11.558	12.541
Carousel-Type-2	Manual	11.003	10.777	10.524	10.794	11.532	12.142	11.037	11.896	12.926	13.949	12.199	13.182
Carousel-Type-2	Cart	10.786	10.560	10.307	10.577	11.315	11.925	10.820	11.679	12.709	13.732	11.982	12.965
Carousel-Type-3	Manual	11.298	11.072	10.819	11.089	11.827	12.437	11.332	12.191	13.221	14.244	12.494	13.477
Carousel-Type-3	Cart	11.081	10.855	10.602	10.872	11.610	12.220	11.115	11.974	13.004	14.027	12.277	13.260

TABLE 8.–Summary of total costs per 1,000 washable pieces for conventional dishwashing systems in cafeterias

Dishwashing station	Clean-tableware-storing method	Table-clearing method			
		Self-bussing	Bus carts	Bus pans	Small tray
		Dollars	*Dollars*	*Dollars*	*Dollars*
Conveyor-rack (2-tank)	Manual	7.994	10.793	10.636	11.603
Conveyor-rack (2-tank)	Cart	7.777	10.576	10.419	11.386
Conveyor-rack (3-tank)	Manual	8.074	10.873	10.716	11.683
Conveyor-rack (3-tank)	Cart	7.857	10.656	10.499	11.466
Flight	Manual	8.197	10.996	10.839	11.806
Flight	Cart	7.980	10.779	10.622	11.589
Door	Manual	9.109	11.908	11.751	12.718
Door	Cart	8.892	11.691	11.534	12.501
Carousel-Type-1	Manual	8.315	11.114	10.957	11.647
Carousel-Type-1	Cart	8.098	10.897	10.740	11.430
Carousel-Type-2	Manual	8.806	11.605	11.448	12.138
Carousel-Type-2	Cart	8.589	11.388	11.231	11.921
Carousel-Type-3	Manual	9.071	11.870	11.713	12.403
Carousel-Type-3	Cart	8.854	11.653	11.496	12.186

TABLE 9.–Example of costs and standard man-hours required per day for a restaurant with moderate dining room service

Task	Standard man-hours	Actual man-hours	Labor utilization	Total costs
	Hours	*Hours*	*Percent*	*Dollars*
Table-clearing	9.9	15.2	65.1	([1])
Dishwashing and storing	11.1	18.0	61.7	([1])
Total	21.0	33.2	63.3	88.88

[1] Breakdown of total cost not available.

study average of 366,267 customers per year, the average system cost per customer is 15.6 cents at 100-percent labor utilization.

The average labor utilization of the food service operations that participated in this research is 64.7 percent. At this performance level, the average annual cost is $78,181 per establishment; an average of 21.3 cents per customer. Average potential labor savings of $20,936 per establishment could be obtained through improved management practices of scheduling and training employees, especially to perform more than one task. Additional data concerning the food service operations which participated in this research are presented in appendix tables 19 and 20.

At 100-percent labor utilization, 53 percent of the total average standard man-hours (all food service operations that participated in this research) is required for the table-clearing task, and 47 percent of the total average standard man-hours is required for both the dishwashing and the clean-tableware-storing tasks. Labor cost for these account for 66 percent of the total system costs.

TABLE 10.–Annual standard man-hour costs in the participating food service operations

Food service operation	Cost at 100-percent performance	Labor utilization performance	Cost at actual performance	Potential annual savings
Number	*Dollars*	*Percent*	*Dollars*	*Dollars*
1	38,478	54.0	61,772	23,294
2	58,080	65.3	76,792	18,712
3	51,909	50.7	80,168	28,259
4	29,766	62.8	43,704	13,938
5	30,492	34.6	66,102	35,610
6	135,762	91.6	145,213	9,451
7	33,033	48.1	54,323	21,290
8	63,888	70.0	81,359	17,471
9	23,958	53.2	37,801	13,843
10	10,527	47.2	19,501	8,974
11	31,218	70.0	41,242	10,024
12	65,340	82.2	73,837	8,497
Average	57,245	64.7	78,181	20,936

METHODS OF IMPROVING DISHWASHING SYSTEMS

There are four general ways to improve dishwashing systems. The first is to modify one or more of the existing tasks by the substitution of less expensive or more efficient methods. A second is to improve a conventional least cost system. A third is to develop a model system, and a fourth is to develop innovative equipment.

Least Cost Methods

One practical method of improving an existing conventional dishwashing system is to replace either the existing method of clearing tables or the method of storing clean tableware, or both, with comparable methods which are less expensive or more efficient. An analysis of one occasion-type restaurant that offers intensive table service will demonstrate the potential savings which may be realized from the substitution of least cost methods (food service operation number 6).

This restaurant has two comparable food service operations in one location, with a dining room, a kitchen, and a dishwashing station located on each of two floors. Each day, this restaurant serves an average of 2,500 customers, has an average of 11.88 washable pieces of tableware per customer, and processes 29,700 washable pieces through the dishwashing systems. Both dishwashing systems have the following components: small-tray table clearing, two-tank, conveyor-rack dish machines, and manual storing of clean tableware. In the dining rooms, 52 man-hours per day are required for the table-clearing task, and 66 man-hours in the dishwashing stations for the dishwashing and clean-tableware-storage tasks. This restaurant is open for business 7 days a week, from 11:30 a.m. until 9:00 p.m.

Table 11 summarizes standard man-hours and costs for an average day with the existing systems. The method used to develop this data is described on page 18 of this publication.

Customers who patronize an "occasion type" restaurant are usually celebrating a special event and desire a leisurely dining atmosphere. Therefore, considering a least cost alternative to the existing methods of clearing tables with small trays and manually storing clean tableware, it would not be practical to change the character of the restaurant by the substitution of one of the methods associated with moderate, minimal, or cafeteria-type service.

Table 7 shows dishwashing system costs of $11.079 per 1,000 washable pieces. From this table, the least cost system for the intensive service restaurant would be the cart-clean-tableware storage method, the large

TABLE 11.–Summary of standard man-hours and costs for the existing system based on an average day

Task	Standard man-hours	Standard labor cost[1]	Total cost	Ratio of labor cost to total cost
	Hours	*Dollars*	*Dollars*	*Percent*
Clear tables	63.60	167.27	167.54	99.14
Wash and store dishes	44.50	117.04	206.50	56.68
Total	108.10	284.31	374.04	76.01

[1] Based on an average labor rate of $2.63 per hour.

tray method for clearing tables, and a two-tank dish machine.

Table 12 indicates a potential labor savings of $23,449 through substitution of the work methods of the alternative system. This system would require four less employees than the existing one [8,916 man-hours saved divided by (363 days, times 6 man-hours per day)]. The net savings from conversion would be $7,116 less than the total labor savings ($23,449 - $16,333) from the increased expense for equipment and floor space. As previously stated, expenses for recruiting, training, separating, and other tasks associated with labor turnover have not been included in total costs. Therefore, an additional net savings of $3,000 could be realized through the reduction of labor turnover costs (estimated cost of $500 per turnover times three employees times two turnovers per year).

There is another substitution option which would further improve the described alternate system. Of the 29,700 washable pieces, approximately 19,800 were processed through the dishwashing station on the first floor, and 9,900 through the dishwashing station on the second floor.

A two-tank, conveyor-rack dishwashing station with a five-man crew can process an average of 31,320 washable pieces in 6 hours of operation. Therefore, the dishwashing station on the first floor is being utilized at 63-percent capacity [100 x (19,800 ÷ 31,200)], and the dishwashing station on the second floor is being utilized at 32-percent capacity [100 x (9,900 ÷ 31,320)]. The crew size could be reduced and the equipment utilization increased by replacing the two-tank, conveyor-rack dishwashing station on the second floor with a carousel-type-1 dishwashing station.

With a three-man crew, this carousel dishwashing station can process an average of 18,762 washable pieces in 6 hours of operation. This substitution would result in a dishwashing station utilization of 53 percent [100 x (9,900 ÷ 18,762)] and a potential reduction of two employees. A labor turnover savings of $2,000 could result from this conversion. These savings would be offset, however, by increased costs of $1,722 for the more expensive carousel-type-1 equipment (3,594,000 washable pieces per year times $11.558 minus $11.079). A more appropriate way to achieve

TABLE 12.–Summary of annual costs and man-hours saved for an alternate dishwashing system

System	Total cost	Standard man-hours to clear tables	Standard man-hours to wash and store tableware	Total standard time	Total standard[1] labor costs	Ratio of labor to total cost
	Dollars	*Hours*	*Hours*	*Hours*	*Dollars*	*Percent*
Existing	135,775	23,092	16,139	39,231	103,177	76
Alternate	119,422	17,562	12,753	30,315	79,728	67
Savings	16,333	5,530	3,386	8,916	23,449	9

[1] Based on an average labor rate of $2.63 per hour.

further efficiency in the overall operation of this establishment would be to consolidate all work stations and dining rooms on one floor and to install either an improved conventional system or a model system.

Improved Conventional Systems

The conventional least cost systems described can be improved by transferring selected work elements from the dishwashing task to the table-clearing task. A more even distribution of work between the dishwashing and the dining room personnel would result. This transfer of work elements would require a minor revision to the soiled-dish tables shown in figures 2, 4, 5, and 9.

The research findings presented in MRR-931, "Labor Utilization and Operating Practices in Table Service Restaurants," show that the nonproductive time of dining room personnel ranges 5 to 10 percent more than that of dishwashing personnel. Random work samples at selected food service operations that participated in this research also showed that nonproductive time of dining room personnel exceeded that of dishwashing personnel. Nonproductivity in the dining room ranged from a high of 50 percent early or late in the meal period to a low of 15 percent during the peak.

An analysis of dishwashing tasks and the associated conventional dishwashing station layouts indicate that the following work elements: Scrap and rack cups, glasses, pitchers, and silverware to soak could be transferred to the table-clearing tasks by moving the overshelves for inverted-dishracks from the dishwasher side of the soiled-dish table to the opposite side. This modification of the soiled-dish table will enable waiters to remove glasses, cups, and pitchers from the tray and to place them in the overhead dishracks. When the racks become full, waiters could pass them across the table to the dishwashers and obtain an empty replacement rack.

Table 13 shows the standard man-hours and total costs for the dishwashing task. Standard man-hours and costs for the table-clearing task and the clean-tableware-storing task are not affected by this improvement. Table 14 shows the total costs for the improved conventional dishwashing system in restaurants and cafeterias.

Installation of the improved conventional system would produce net annual savings of $20,267 and would require four less employees [(10,414 man-hours saved divided by (363 days times 6 man-hours per day)]. Table 15 shows the potential time and cost savings. The net savings from the conversion would be $7,121 less than the total labor savings ($27,388 - $20,267) from the increased expense for equipment and floor space with the large-tray method of clearing tables and the dish-cart method of storing clean tableware.

Model Dishwashing Systems

Figure 16 shows the layout for a model two-tank dishwashing station. The large-tray method is used for the table-clearing task, the new method for the dishwashing task, and the dish-cart method for the clean-tableware-storing task.

The method of handling large trays by dining room personnel at the model dishwashing station is comparable to that described for the carousel dishwashing task. Dining room personnel deposit large trays on the soiled-dish storage rack that contains overshelves for inverted dishracks (item 1). These overshelves are the same type as those shown in figure 15. Dining room personnel remove glasses, cups, and similar pieces of inverted tableware and place them in dishracks on the bottom overshelf. Empty inverted dishracks are obtained from the top overshelf. Nondisposables are placed in the trash can (item 2), and silverware is placed in the portable silverware soaking sink (item 3). Dining room personnel obtain clean trays from one of the lower shelves on the dishrack (item 1) before proceeding to other work stations in the kitchen for food pickup.

The dishwasher at the soiled-dish table (item 4) removes the large tray from the dish storage rack (item 1) and places it on the table. Empty flatware and silverware racks are obtained from the empty dishrack conveyor (item 8) and placed on the table adjacent to the large tray. Garbage is dumped from flat tableware into the scrap trough. The tableware is placed in racks, spray-rinsed with the suspended spray-rinse arm (item 11), and pushed onto the roller conveyor (item 5). Large trays are racked and processed through the dish machine. Racks of inverted tableware are removed from the soiled-dish storage rack (item 1) and placed directly onto the roller conveyor. The portable silverware soaking sink (item 3) is rolled to the soiled-dish table; silverware is removed and placed in the silverware racks; and the racks are pushed onto the roller conveyor. Filled racks of soiled tableware flow by gravity on the roller conveyor (item 5) to the dish

TABLE 13.–Standard man-hours and costs per 1,000 washable pieces for improved dishwashing

Dishwashing station	Type of service	Average capacity of dishwashing crew	Average size of dishwashing crew	Standard labor	Labor cost [1]	Equipment and supplies		Floor space	Total costs
						Owning	Operating		
		Number	*Number*	*Hours*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Door	Restaurant	1,500	2	0.896	2.356	0.608	0.519	0.348	3.831
Do	Cafeteria	1,170	2	1.080	2.840	.780	.519	.348	4.487
Conveyor-rack (2-tank) ..	Restaurant	4,520	4	.882	2.320	.317	.466	1.292	4.395
Do	Cafeteria	3,730	4	1.071	2.817	.395	.466	1.292	4.970
Conveyor-rack (3-tank) ..	Restaurant	7,350	6	.818	2.151	.259	.506	1.561	4.477
Do	Cafeteria	5,950	6	1.007	2.648	.336	.506	1.561	5.051
Flight	Restaurant	6,900	5	.723	1.901	.419	.419	1.871	4.610
Do	Cafeteria	6,410	6	.934	2.456	.426	.419	1.871	5.172

[1] Standard man-hours multiplied by the average hourly rate of $2.63.

TABLE 14.–Costs per 1,000 washable pieces for improved conventional systems in restaurants and cafeterias

Type of dish machine	Type of restaurant service[1]			Cafeteria service[2]
	Intensive	Moderate	Minimal	
	Dollars	*Dollars*	*Dollars*	*Dollars*
Door	10.150	8.988	8.475	6.966
Conveyor-rack (2-tank)	10.714	9.552	9.039	7.449
Conveyor-rack (3-tank)	10.796	9.634	9.121	7.503
Flight	10.929	9.767	9.254	7.651

[1] Dish carts and large trays.

[2] Dish carts and self-bussing.

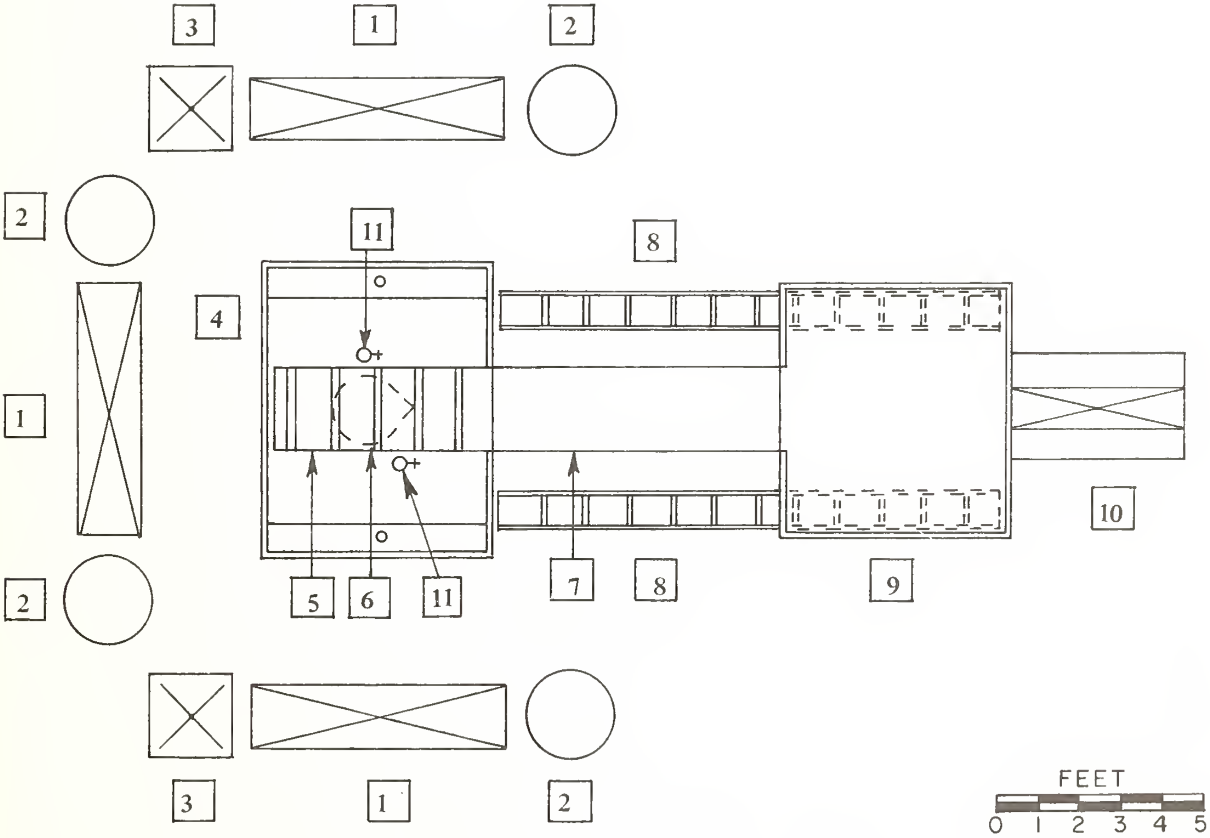

Figure 16.–Layout for model two-tank dishwashing station: 1, Soiled-dish storage racks (3) with overshelves (2 per rack) for inverted dishracks; 2, trash cans (4); 3, portable silverware soaking sinks (2); 4, soiled-dish table with scrap trough; 5, roller conveyor, gravity type; 6, disposal (5 hp.); 7, dish machine; 8, empty dishrack conveyors, gravity type (2); 9, clean dish table; 10, silverware sorting table with overshelf and undershelf; 11, suspended spray-rinse arm.

TABLE 15.–Summary of annual costs and standard man-hour savings for an improved conventional system

System	Total costs	Standard man-hours to clear tables	Standard man-hours to wash and store tableware	Total standard time	Total standard[1] labor costs	Ratio of labor to total cost
	Dollars	*Hours*	*Hours*	*Hours*	*Dollars*	*Percent*
Existing	135,775	23,092	16,139	39,231	103,177	76
Improved	115,508	17,562	11,255	28,817	75,789	66
Savings	20,267	5,530	4,884	10,414	27,388	10

[1] Based on an average labor rate of $2.63 per hour.

machine (item 8). Racks of clean tableware are pushed by the machine onto the clean dish table (item 9).

The dishwasher working at the clean dish table (item 9) removes flat tableware from the dishrack and loads the pieces onto a clean dish cart. Racks of inverted tableware are loaded directly onto a dish cart. Silverware is sorted and placed in silver cylinders at the silverware sorting table (item 10). Empty flatware and silverware racks are returned to the soiled-dish table on the gravity-type roller conveyor (item 8).

The layout for the model two-tank dishwashing station has working space for two men at the soiled-dish table, two at the clean dish table, and one at the silverware sorting table. At 100-percent labor utilization, a four-man crew could process 5,180 pieces per hour for restaurant service, or 4,550 pieces per hour for cafeteria service. Four men are needed instead of five, since silverware sorting is not a full-time job and would be handled by the others.

Figure 17 shows the layout for the model three-tank dishwashing station. The same operating methods are used for the two-tank and three-tank dishwashing stations with one exception—flat tableware is not spray-rinsed when a three-tank dish machine is used.

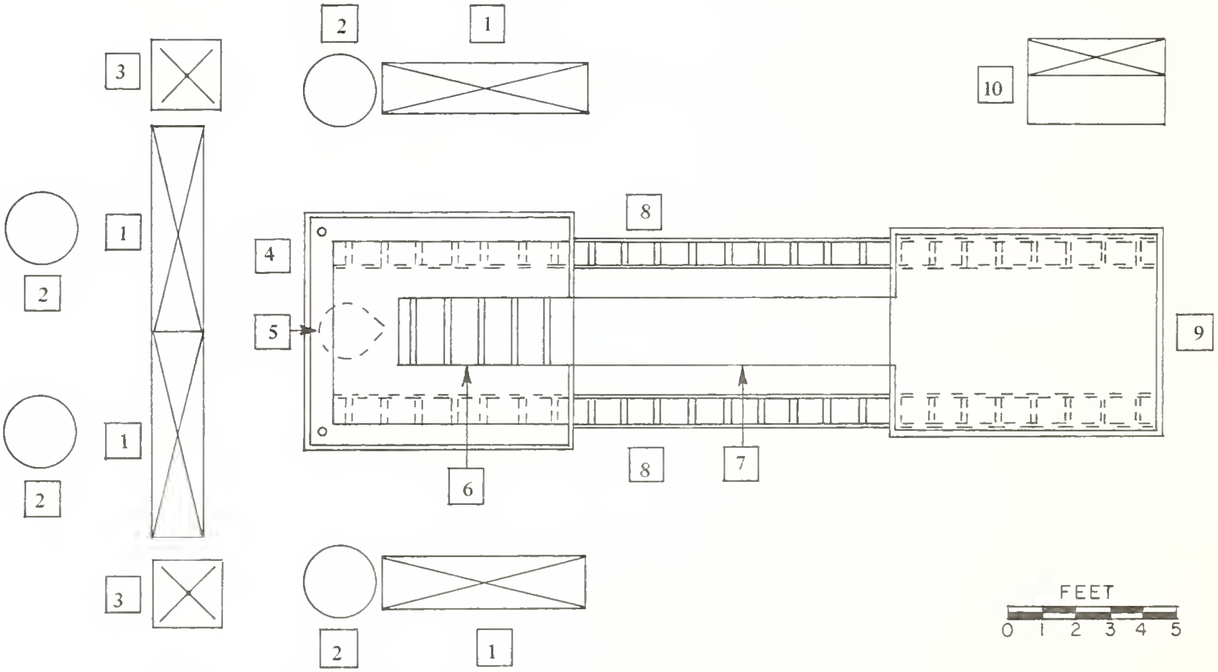

Figure 17.–Layout for model three-tank dishwashing station: 1, Soiled-dish storage racks (4) with overshelves; (2 per rack) for inverted dishracks; 2, Trash cans (4); 3, portable silverware soaking sinks; 4, soiled-dish table with scrap trough; 5, disposal - (5 hp.); 6, roller conveyor, gravity type; 7, dish machine; 8, empty dishrack conveyors, gravity type (2); 9, clean dish table; 10, silverware sorting table with overshelf and undershelf.

TABLE 16.–*Standard man-hours and costs per 1,000 washable pieces for model dishwashing tasks*

Dishwashing station	Type of service	Average capacity of dishwashing crew	Average size of dishwashing crew	Standard labor[1]	Labor cost	Equipment and supplies		Floor space	Total costs
						Owning	Operating		
		Number	*Number*	*Hours*	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Conveyor-rack									
(2-tank) . .	Restaurant	5,180	4	0.765	2.012	0.297	0.466	1.603	4.378
Do	Cafeteria	4,550	4	.873	2.296	.338	.466	1.603	4.703
Conveyor-rack									
(3-tank) . .	Restaurant	10,530	7	.667	1.754	.190	.506	2.174	4.624
Do	Cafeteria	10,310	8	.775	2.038	.194	.506	2.174	4.912

[1] Standard man-hours multiplied by the average hourly rate of $2.63.

The layout shown for the model three-tank dishwashing station has working space for five men at the soiled-dish table, five at the clean dish table, and one at the silverware sorting table. At 100-percent labor utilization, a seven-man crew could process 10,530 pieces per hour for restaurant service, and an eight-man crew could process 10,310 pieces per hour for cafeteria service. An additional man is needed in cafeteria service to wash the trays. As a matter of practicality, additional space was made available at the ends of the soiled-and clean dish tables. This allows greater flexability for the workers to help at other work stations.

Table 16 shows the standard man-hours and costs per 1,000 washable pieces for the model dishwashing task. Table 17 shows the total costs for restaurants and cafeterias.

The model has several features which make it superior to both conventional and improved conventional dishwashing systems. The first is a straight-line production flow, as opposed to the U-shaped flow of the conventional conveyor-rack dishwashing station and the flight dishwashing station. The straight-line production flow and gravity-type conveyors minimize employee walking.

Installation of the roller conveyor in the soiled-dish table eliminates the need to push each rack of soiled tableware manually into the machine. Transfer of the scrap and rack glasses, cups, and pitchers from the dishwashing to the table-clearing task makes practical the installation of dish tables that have accessible work space on more than one side. As a result of this dish table design, a dishwasher may process tableware directly to and from the machine without waiting for a coworker to step aside or walk around him.

Installation of the model system in the food service operation described previously would produce net annual savings of $20,451. Table 18 shows the potential time and cost savings. This model system would require five less employees (11,676 man-hours saved, divided by 363 days times 6 man-hours per day). Net savings would be $10,256 less than the total labor savings ($30,707 to $20,451) from the increased equipment cost.

TABLE 17.–Costs per 1,000 washable pieces for model dishwashing systems in restaurants and cafeteria

Type of dishwashing station	Average capacity of dishwashing crew	Average size of dishwashing crew	Costs by type of restaurant service: Intensive	Moderate	Minimal	Cost for cafeteria service
	Number	*Number*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
Conveyor-rack (2-tank)	5,180	4	10.697	9.535	9.022	—
Do	4,550	4	—	—	—	7,182
Conveyor-rack (3-tank)	10,530	7	10.943	9.781	9.268	—
Do	10,310	8	—	—	—	7,391

TABLE 18.–Summary of annual costs and standard man-hours saved for a model system

System	Total costs	Standard man-hours to clear tables	Standard man-hours to wash and store tableware	Total standard time	Total standard[1] labor costs	Ratio of labor to total cost
	Dollars	*Hours*	*Hours*	*Hours*	*Dollars*	*Percent*
Existing	135,775	23,092	16,139	39,231	103,177	76
Model	115,324	17,562	9,993	27,555	72,470	63
Savings	20,451	5,530	6,146	11,676	30,707	13

[1] Based on an average labor rate of $2.63 per hour.

Innovative Equipment

Additional savings for dishwashing systems may be possible through the development of innovative equipment to transfer more work elements from the dishwashing to the table-clearing task. This could be done by developing collapsible dishracks and special dining room stations where tableware could be scrapped, sorted, and racked as it is removed from tables.

The proposed innovation plan would necessitate the installation of special dining room stations. These stations would have sufficient space for the storage of empty, collapsible dishracks and full dishracks, and for dining room employees to scrap and rack dishes. This station is illustrated in figure 18. It is estimated that a restaurant with 250 seats that serves an average of 1,000 customers per day would require these stations.

The station shown in figure 19 would consist of a dish machine with an accumulator conveyor at each end. Racks of soiled tableware on carts would be loaded onto an accumulator conveyor where they would feed continuously into the dish machine. Clean tableware leaving the machine would accumulate on the conveyor until removed and placed on carts for recirculation. Flat tableware would be deracked before stacking onto carts. This system would require approximately a 40-percent increase in tableware over a conventional system.

The potential labor savings for the dishwashing task by the installation of the proposed plan would be offset by increased cost for dining room stations, tableware, dishracks, and dining room labor. Further research is required to evaluate the economic feasibility of such an installation.

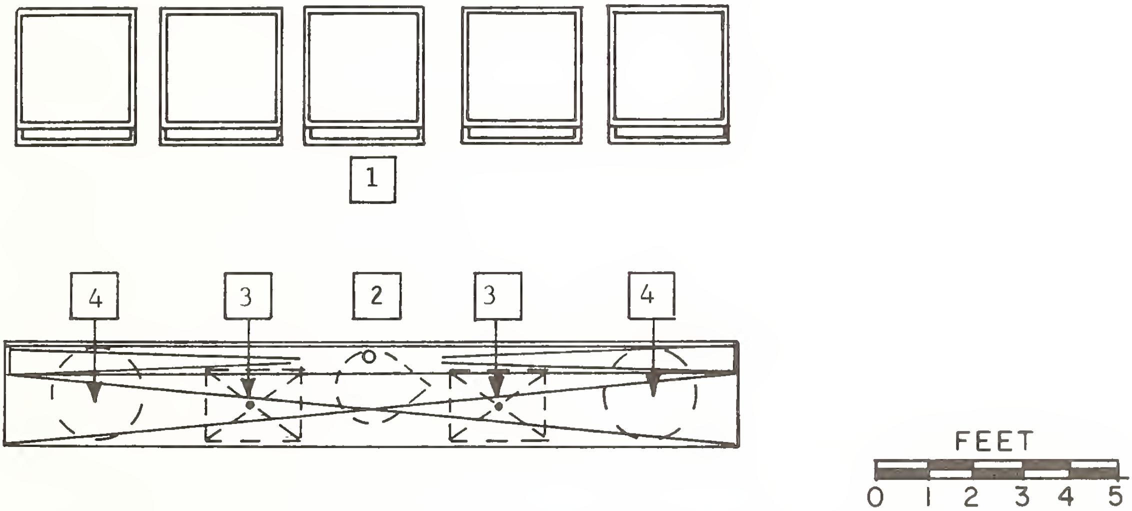

Figure 18.–Layout of a dining room station for scrapping and racking tableware: 1, Soiled-dishrack carts (5); 2, soiled-dish table with 5 hp. disposal, overshelves (2); per inverted dishracks, and prerinse sprays (2-optional); 3, portable silverware soaking sinks (2); 4, trash cans (2).

EQUIPMENT SELECTION AND MAINTENANCE

The selection and maintenance of dishwashing and dish-handling equipment should be considered carefully, because the cost of acquisition and operation are significant. The costs and merits of specific types of dishwashing systems for various kinds of food service operations are presented elsewhere in this publication. Before purchasing any equipment, check your local health codes and the National Sanitation Foundation's standards to avoid compliance problems. Detailed information on standards can be obtained from Standard Number's 2, 3, and 5 of the National Sanitation Foundation (NSF), Ann Arbor, Mich. 48106.

Also, before the final purchase of a specific piece of equipment, verify the availability of parts and maintenance service.

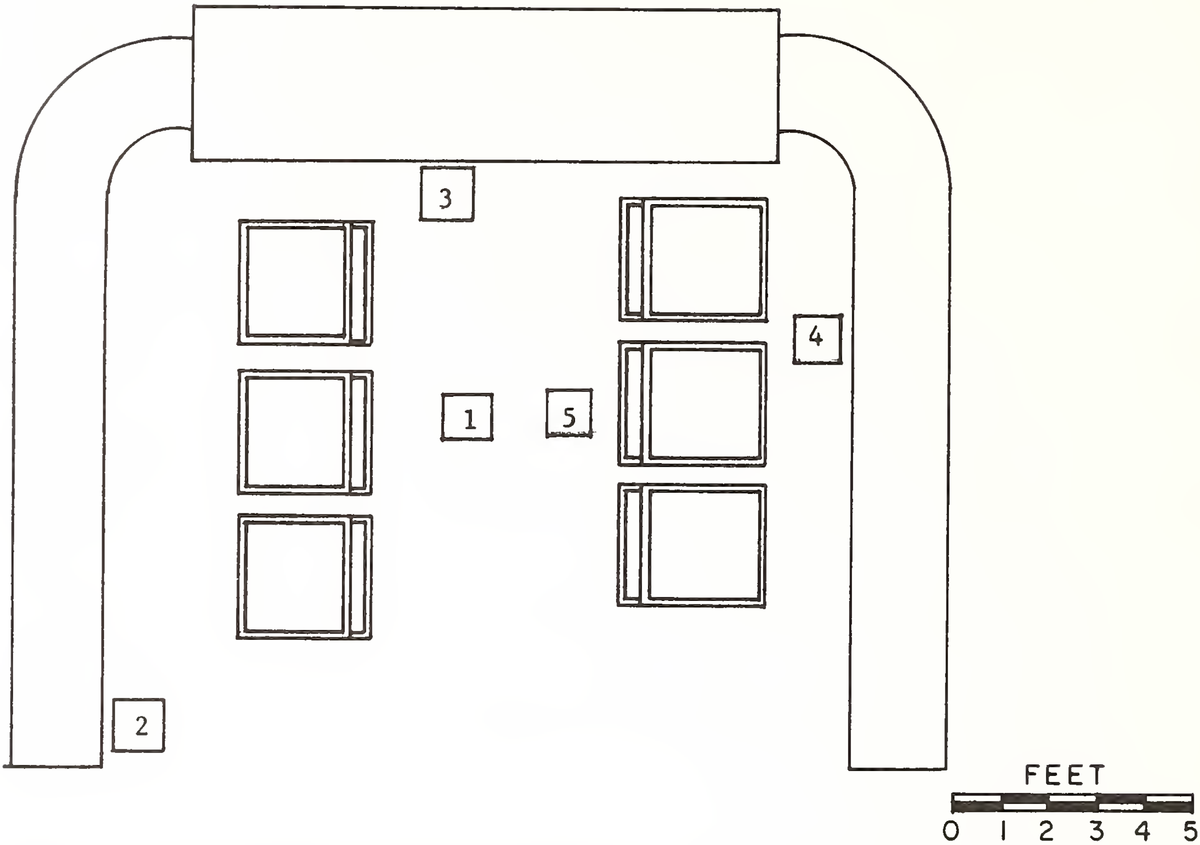

Figure 19.–Layout of a dishwashing station for innovative equipment: 1, Soiled-dish carts; 2, soiled-dish table with conveyor; 3, dish machine; 4, clean dish table with conveyor; 5, clean dish carts.

Mobile Handling Equipment

Mobile handling equipment can save considerable time, effort, and money in a dish room operation.[2] Before purchasing this equipment, make sure that your aisles and doorways are wide enough to permit the passage of equipment, and that there is room for storage. Eighteen-gage stainless steel is recommended, because it is easily cleaned and very durable. All corners, inside and out, should be coved. Maneuverability is an important criteria for mobile equipment; therefore, carts should be equipped with a 5-inch, hard rubber caster that swivels. The casters should be durable, impervious to dirt and moisture, and easy rolling. Two of them should have wheel locks.

To reduce damage to equipment, doors, and walls, one should use bumpers. A continuous rubber bumper around the bottom of the equipment offers the most effective protection. Doughnut-shaped bumpers placed on the cart handles and on the shaft above the casters will provide additional protection. A maintenance program for mobile handling equipment is essential if it is expected to last. Daily cleaning of the equipment and periodic checking of the casters and bumpers for wear will accomplish this goal.

DISH ROOM CONSTRUCTION

The proper construction of the dish room is important to the overall operation of successful food facility. The various types of lighting, ceilings, walls, floors, and drains should be compared and selected on their basis of cost, durability, safety, compliance to health codes, and attractiveness.

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[2] Kotschevar, L. H., and Terrell, M. E. Food service planning: Layout and equipment. pp. 243, 279; 394-398. New York and London. 1966.

Lighting in the dish room should eliminate all glare and shadows around the work area. The use of 30 to 45 foot-candles of light should accomplish this and prevent eye strain. Fluorescent lighting is an excellent choice, because it provides excellent illumination with very little glare. A lighting engineer should be able to handle any problems that may be encountered.

A common problem in the dish room is noise, due mainly to dishwashers, mobile handling equipment, waste disposals, and dining room personnel. An accoustical ceiling can reduce noise levels between 40 and 95 percent, depending on choice of material. Lessening the noise in the dish room also provides better working conditions for employees and a more enjoyable meal for customers in the dining room. Before purchasing an accoustical ceiling, consider the cost, fire resistance, cleanability, and attractiveness of the material. A wide variety of ceilings is available, and it should be easy to obtain the proper material for a particular type.

Walls and floors should be impervious to moisture and grease, easy to clean, hard surfaced, and free from all cracks and crevices. A glazed wall tile meets these requirements and should be used, if possible. Painted walls can also be used in most operations; however, the paint must meet the requirements mentioned above. A combination of glazed tile on the bottom part and paint on the top part of the walls can also be used. Bumpers should be placed on tiled walls to protect them from possible damage from trash can handling and from mobile-type equipment. One of the most important conditions is that the floors provide surefootedness. Some of the more common types of floors are ceramic, quarry, terrazzo, cement, and asphalt.

Drains should be located at several points in the dish room. The floor should have a pitch of one-fourth inch per foot toward the drain. Check and clean the drains often to avoid any blockage which could cause considerable safety and sanitation problems. At the end of every working day, the dish room should be washed down. A wall-mounted retractable hose will facilitate this housekeeping task.

Dish Machines

Purchasing dishwashing equipment can be a difficult task because of the numerous types on the market today. Before purchasing a dish machine, restaurant operators should determine answers to the following questions: (1) What is the volume of soiled tableware generated in the dining room? (2) Is space available in the back of the house to install a dish machine and auxiliary equipment with sufficient capacity to process soiled tableware within a 3-hour period. (3) Where can soiled tableware be temporarily stored if back-of-the-house space is inadequate? (4) Will there be enough hot water?[3] (5) What type of heat (electric, gas, or steam) is available and which will be most economical? (6) What are the utility rates in the area? With these questions answered, the operator will be in a better position to select a dish machine.

Previously, the optimum size dish machines were discussed. Because of space restrictions in the back of the house and cost considerations, not every restaurant will be able to accommodate an optimum system, and alternate selections will be necessary. When selecting a dish machine, be sure that it is NSF approved; a local dealer should be able to provide proper maintenance. Also, the machine should be equipped with an automatic detergent monitor and dispenser, as well as with an automatic drying agent dispenser.

Dishwashing systems are expensive, but they should last for many years if a maintenance program is followed. Many detergent suppliers can provide a preventive maintenance program. A 10-step procedure[4] should be followed daily:

(1) Be sure that the overflow standpipe is in proper position and that scrap trays are clean and in place.
(2) Inspect containers and hang them in position.
(3) Check wash arms, rinse arms, and spray jets to be sure they are clean and in the correct position.
(4) Close the drain valve tightly.
(5) Open the fill valves to run water into the tanks and shut the valves when water reaches the top of overflow.
(6) Turn on gas, electric, or steam heaters.
(7) Put proper charge of detergent in reservoir.
(8) Be sure electric dispenser is operating.
(9) Check to see that the rinse additive reservoir is filled.
(10) Turn on the machine and be sure the temperatures for wash and rinse are correct.

To insure proper sanitation, the water in dish machines must be changed after every meal. If the tableware appears dirty before the end of the dishwashing cycle, change the water immediately. Before changing the water and initiating the 10-step procedure, turn the dish machine off and drain the water.

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[3] (a) The prewash cycle should not be over 120° F.; (b) The wash cycle should be 140° to 160°; (c) The rinse cycle should be 160° to 180°; (d) The final rinse should be at least 180°.

[4] Courtesy of Economics Laboratory, Inc.

After the final cycle of the dish machine, only people with clean hands should touch the clean tableware. A minimum of two people should be used in any dishwashing operation–one to handle only soiled tableware and one to handle only clean tableware. If conditions ever demand that an employee must change from the soiled-dish table to the clean dish table, it is imperative that he wash his hands first.

Tables

In most dish room operations, a considerable volume of tableware and dishracks are loaded on and from soiled-dish and clean dish tables. To minimize the possibility of dented or sagging table surfaces, or both, tables should be fabricated from properly sized material. Both the soiled-dish and the clean dish table should be fabricated from 14-gage stainless steel and braced laterally with 1½- by 5-inch, 12-gage stainless steel channeling. The maximum spacing of channeling is 6 feet between centers.

Tables should be supported by 1 5/8-inch O.D., adjustable, 10-gage metal legs. If tables are against a wall, provide a back splash 10 inches high. Edges adjacent to aisles should be turned up 3 inches and rolled on a 1½-inch diameter with bullnose corners. Shelves for glass and cup rack storage should be fabricated from 14-gage stainless steel and supported with 1 3/4-inch O.D., 16-gage stainless steel tubing. Shelves should be supported with 1½- by 1½-inch, 12-gage stainless steel angles on no more than 6-foot centers.

The tubular support on the front edge of the overshelf adjacent to the dish machine should be open on both ends to provide drainage from the shelf on to the soiled-dish table. Tables should be pitched one-eighth inch per foot toward the dish machine to provide proper drainage. All interior corners should have a 1/4-inch radius, and tables should be painted with an undercoat to deaden sound. The soiled-dish table should have a built-in garbage disposal, and a prewash sink with a flexible spray arm should be provided for two-tank, conveyor-rack machines.

Waste Disposals

A waste disposal should be considered for today's dish room, because it will help to eliminate garbage handling and increase usable floor space by eliminating trash cans. There are many models on the market, and each should be analyzed for a particular operation. Conventional models range from 1/4 hp. ($350) to 5 hp. ($1,300), with ranges in between. For general use, a 1½- to 3-hp. disposal is sufficient, but a large restaurant that serves steak and lobster would require a 5-hp. model because of the large volume of bones being discarded.

The disposal should be equipped with a rubber garbage blocks, stainless steel cone, overhead spray, and a built-in silverware guard. The drain should have a pitch of at least one-fourth inch per foot. Water consumption should also be considered: a small unit requires 2 to 3 gallons per minute, while the large units need 8 to 10 gallons per minute. Before purchasing a disposal, be sure to check applicable local health codes.

APPENDIX

Exhibit A-Glossary of Terms

Dish carriers.—A bus pan, small tray, or large tray that is used by employees to carry soiled tableware.

Dish machine.—A machine, commonly referred as dishwashing machine or dishwasher, used to clean washable tableware.

Dishrack.—A carrier used for conveying dishes through a dish machine.

Dishwasher.—An employee who works in a dishwashing station.

Flat tableware.—All plates, saucers, bowls, and other dish ware which are stacked flat while storing or transporting, but which are placed vertically into racks for washing.

Inverted tableware.—All cups, glasses, pitchers, and similar ware which are normally placed upside down in racks for washing, transporting, or stowing.

Normal time.—Either the product of recorded time multiplied by a pace-rating factor, or the summation of universal standard data time increments for basic hand, arm, body, and foot motions.[5]

Pace-rating factor.—An index that is applied by the time study analyst and that compares the performance (speed or tempo) of the operator under observation with the analyst's own concept of normal performance[6] In this research, normal pace of 100 percent was the equivalent effort required to walk at a speed of 3 miles per hour or to deal 52 cards in four equal stacks into the four corners of a 1-foot square within one-half minute.

Productive labor.—The product of normal time multiplied by a factor and fatigue allowance.

Recorded time.—The actual time value for the performance of a specific work element, read from a stopwatch and recorded manually on a time study form.

Scrapping.—The disposing of leftover food, beverages, and remnants remaining before tableware is inserted in the dish machine.

Tableware.—All items, including nondisposables, such as paper napkins and place mats, and nonwashables, such as linen napkins, tablecloths, and breadbaskets, used to provide a table setting for a customer.

Total costs.—The summation of costs per 1,000 washable pieces for productive labor, equipment, utilities, maintenance repairs, supplies, and washable tableware.

Washable tableware.—All plates, saucers, bowls, cups, and silverware that are washed through a dish machine. Does not include trays or bus pans.

Work elements.—The subdivision of a task composed of a sequence of several basic arm and body motions or a machine process or activity that is distinct, describable, and measurable. A work element has a clearly defined starting and stopping point.[7]

Exhibit B—Description of Research Methodology

Twelve food service operations were selected to provide a cross section of the operating methods and equipment commonly used in washing tableware. Each operation was analyzed to determine the volume of tableware handled, the type of customer service rendered, and the types of equipment used in handling, washing, and storing tableware. The amount of actual man-hours and costs for operating each dishwashing system was also obtained.

Determination of Standard Time Per 1,000 Washable Pieces for Each Dishwashing System

Work elements at each food service operation, which were related to dishwashing systems, were identified and analyzed to establish benchmark work elements that could be consistently identified and accurately timed with a decimal minute stopwatch. During the time study, a pace-rating factor was posted for each recorded time value. Normal time values were then posted to summary sheets for each food service operation and for each type of dishwashing system.

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[5] Maynard, H. B. Industrial engineering handbook. McGraw-Hill Book Co. Inc. Chapters 3-12. 1963.

[6] SAM Committee on Rating of Time Studies Advanced Management 6(3):110. New York. 1941.

[7] American Society of Mechanical Engineers Industrial Engineering Terminology. New York. 1955.

All repetitive work elements have an accuracy level of plus or minus 5 percent with two standard errors. Repetitive work elements are those that occur more than 10 times per day. Nonrepetitive work elements do not have a 5-percent level of accuracy.

In some instances, the review and analysis of the summary sheets revealed that repetitive work elements did not meet the plus- or minus-5-percent accuracy level. An analysis of these time values revealed that they were obtained from employees who were either improperly trained or who were working under adverse operating conditions. In these instances, normal time values were developed from Universal Standard Data.

A productive time value for each work element was calculated by multiplying the normal time by a personal and fatigue allowance of 115 percent by the number of occurrences of the work element per 1,000 washable pieces of tableware. An unavoidable delay allowance was applied to the total standard time values for a specific task. The standard time values shown for specific types of dishwashing systems do not include an allowance for makeready and cleanup time, because the specific duties related to this work varied among the 12 operations.

Determination of Total Costs per 1,000 Washable Pieces For Each Dishwashing System

Total costs include labor, equipment, utilities, maintenance repair, washable tableware, dish carriers, and floor space. Costs for general management and other administrative expenses are not included. Labor costs are based on the standard time values and average wage rates, plus fringe costs for social security, health insurance, vacation pay, and profit-sharing plans from the 12 food service operations that participated in this research. Costs of owing equipment were based on manufacturer's list prices, plus interest rates on investments. Costs for operating dishwashing equipment were based on information supplied by equipment and detergent manufacturers. They include the cost of heating water and purchasing detergents and drying agents. The cost of occupying floor space allocated to dishwashing systems was based on annual rent, with maintenance charges added.

Although the impact of scrapping practices, detergents, and chemical additives on rejection rates was considered, it proved to be insignificant. The rejection rate per 1,000 washable pieces could become significant if employees are not properly trained in scrapping practices and in dish machine maintenance. When scrapping practices, water temperatures, detergent and drying-agent levels, and routine cleaning and maintenance procedures were properly supervised, rejections were less than five per 1,000 pieces washed.[8] The effect of scrapping methods on dishwashing-system costs is significant and has been presented elsewhere in this report.

Information obtained in the 12 operations revealed that breakage and damage to tableware were a relatively small part of replacement cost. The major reasons for replacement were disappearance as a result of pilferage and breakage as a result of inadequate facilities and training methods, rather than differences in dishwashing systems.

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[8] Based on a sample of 23,500 washable pieces, the rejection rates per 1,000 pieces for the specific types of tableware were as follows: Flatware, 3.17; cups, 2.41; glasses, 6.35; and silverware, 9.11.

TABLE 19.–Total cost for the dishwashing systems of participating food service operations

Food service operation	Type service[1] and table-clearing method	Dishwashing station	Clean-tableware-storing method	Average customer count per day	Number washable pieces per customer	Number washable pieces per day	Cost per 1,000 washable pieces	100-percent cost per day
Number				*Number*	*Number*	*Number*	*Dollars*	*Dollars*
1 . . .	Large tray (I)	Conveyor-rack (3-tank)	Manaul (I)	675	13.83	9,335	11.376	106
2 . . .	Bus-cart (C)	Conveyor-rack (2-tank)	Cart	1,350	11.23	15,161	10.576	160
3 . . .	do	Flight	do	1,350	9.81	13,244	10.779	143
4 . . .	Small tray (M)	Door	Manual	700	10.01	7,007	11.715	82
5 . . .	Large tray (I)	Flight	Cart	600	12.28	7,368	11.343	84
6 . . .	Small tray (I)	Conveyor-rack (2-tank)	Manual	2,500	11.88	29,700	12.594	374
7 . . .	Bus-cart (M)	Carousel Type-1	do	800	10.22	8,176	11.108	91
8 . . .	Bus-cart (I)	Flight	Cart	1,000	14.60	14,600	12.069	176
9 . . .	Large tray (I)	Carousel Type-1	Manual	500	11.13	5,565	11.775	66
10 . . .	Bus-pan (O)	Door	do	300	9.45	2,835	10.303	29
11 . . .	do	do	do	1,000	8.34	8,340	10.303	86
12 . . .	Large tray (I)	Carousel Type-1	Cart	1,335	11.69	15,606	11.558	180
	Average			1,009	11.31	11,410	11.208	131

[1] (I) indicates intensive, (M) indicates moderate, and (O) indicates minimal restaurant service.

TABLE 20.–Labor utilization in the participating food service operations

Food service operation	Number washable pieces per day	Dishwashing and clean-tableware-storing task: Standard time per 1,000 pieces	Dishwashing and clean-tableware-storing task: Standard time per day	Dishwashing and clean-tableware-storing task: Actual time per day	Dishwashing and clean-tableware-storing task: Performance	Table-clearing task: Standard time per 1,000 pieces	Table-clearing task: Standard time per day	Table-clearing task: Actual time per day	Table-clearing task: Performance	Total system: Standard time per day	Total system: Actual time per day	Total system: Performance
	Number	*Hours*	*Hours*	*Hours*	*Percent*	*Hours*	*Hours*	*Hours*	*Percent*	*Hours*	*Hours*	*Percent*
1 . . .	9,335	1.432	13.4	32.0	41.9	1.629	15.2	21.0	72.4	28.6	53.0	54.0
2 . . .	15,161	1.358	20.6	25.5	80.8	1.072	16.3	31.0	52.6	36.9	56.5	65.3
3 . . .	13,244	1.221	16.2	33.0	49.1	1.072	14.2	27.0	52.6	30.4	60.0	50.7
4 . . .	7,007	1.888	13.2	25.1	52.6	1.645	11.5	14.2	81.0	24.7	89.3	62.8
5 . . .	7,368	1.042	7.7	36.0	21.4	1.629	12.0	21.0	57.1	19.7	57.0	34.6
6 . . .	29,700	1.497	44.5	66.0	67.4	2.142	63.6	52.0	122.3	108.1	118.0	91.6
7 . . .	8,176	1.322	10.8	25.0	43.2	1.214	9.9	18.0	55.0	20.7	43.0	48.1
8 . . .	14,600	1.042	15.2	33.0	46.1	1.744	25.5	26.0	98.1	40.7	59.0	70.0
9 . . .	5,565	1.322	7.4	16.0	46.3	1.629	9.1	15.0	60.7	16.5	31.0	53.2
10 . . .	2,835	1.888	5.4	11.5	47.0	1.061	3.0	6.3	47.6	8.4	17.8	47.2
11 . . .	8,340	1.888	15.7	20.0	78.5	1.061	8.8	15.0	58.7	24.5	35.0	70.0
12 . . .	15,606	1.008	15.7	32.0	49.1	1.629	25.4	18.0	141.1	41.1	50.0	82.2
Totals	136,937	([1])	185.8	355.1	([1])	([1])	214.5	264.5	([1])	400.3	619.6	([1])
Average	11,411	1.360	15.5	29.6	52.4	1.561	17.8	22.0	80.9	33.4	51.6	64.7

[1] Not applicable.

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